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CONTENTS

NORTH AMERICAN FOREST THRUSHES, Painting by *William C. Dilger* facing page 171

ADAPTIVE MODIFICATIONS AND ECOLOGICAL ISOLATING MECHANISMS IN THE THRUSH GENERA *CATHARUS* AND *HYLOCICHLA* *William C. Dilger* 171

MINIMUM SPACE REQUIREMENTS OF SOME NESTING PASSERINE BIRDS *James R. Beer, Louis D. Frenzel and Norman Hansen* 200

ON CERTAIN CHARADRIIFORM BIRDS OF BAFFIN ISLAND *George M. Sutton and David F. Parmelee* 210

DESTRUCTION OF WARBLERS ON PADRE ISLAND, TEXAS, IN MAY, 1951 *Pauline James* 224

RE-ESTABLISHMENT OF BREEDING POPULATIONS OF LONG-BILLED CURLEWS IN WASHINGTON ..... *Charles F. Yocom* 228

JUVENILE MORTALITY IN A RING-BILLED GULL COLONY *John T. Emlen, Jr.* 232

OBSERVATIONS OF ELEGANT TERNS AT SAN DIEGO, CALIFORNIA *Burt L. Monroe, Jr.* 239

GENERAL NOTES

LONG-TAILED JAEGER IN KANSAS ..... *Larry D. Mosby and William M. Lynn* 245

NOCTURNAL PREDATION ON SONG SPARROW EGGS BY MILKSNAKE *Harold D. Mahan* 245

CAPE MAY WARBLER SUMMERING IN LOWER MICHIGAN .. *Dale A. Zimmerman* 245

THE NORTHERNMOST NESTING OF THE ROUGH-LEGGED HAWK IN NORTH AMERICA *Charles O. Handley, Jr.* 246

PURPLE FINCH NESTING AT TOLEDO, OHIO *Harold F. Mayfield and John M. McCormick* 249

WINTER FOODS OF EVENING AND PINE GROSBEAKS IN WEST VIRGINIA *Maurice Brooks* 249

A LINCOLN SPARROW ON THE EAST COAST OF FLORIDA ..... *Robert A. Norris* 250

BREEDING RECORD OF BREWER SPARROW IN NORTHWESTERN MONTANA *Paul H. Baldwin* 251

UNUSUAL EGGS OF THE BOAT-BILLED HERON ..... *Emmet R. Blake* 251

THE AFTERSHAFT IN JACAMARS AND PUFF-BIRDS ..... *Charles G. Sibley* 252

PROCEEDINGS OF THE THIRTY-SEVENTH ANNUAL MEETING *Phillips B. Street* 254

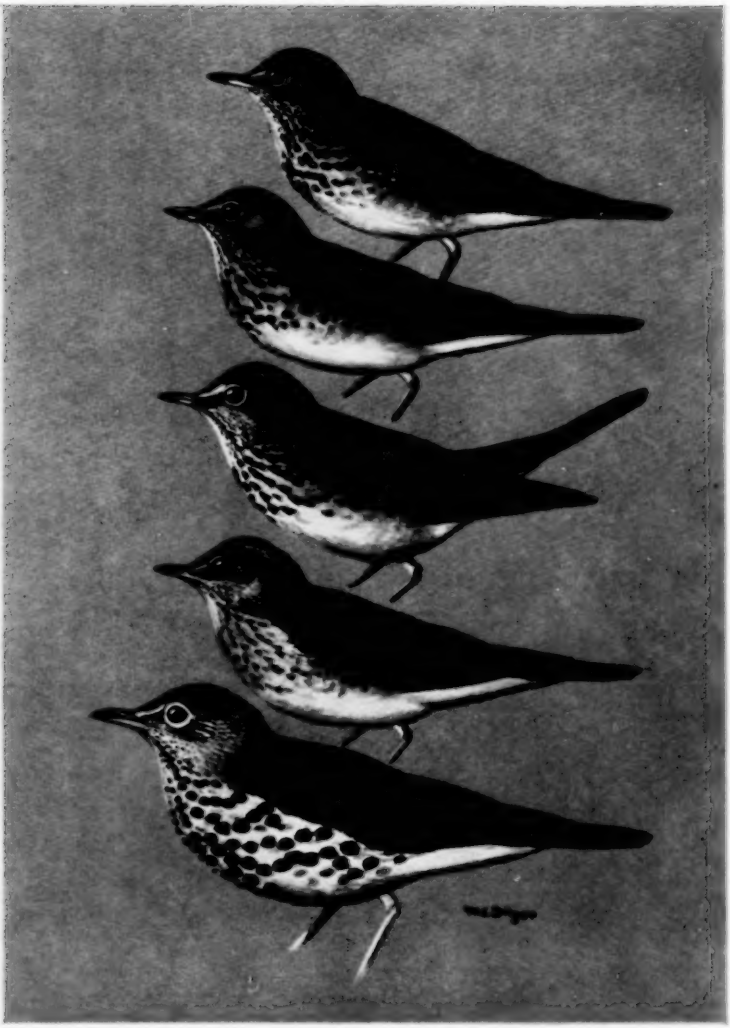
CONSERVATION SECTION: POISONS AND WILDLIFE ..... *Lee E. Yeager* 261

LETTER TO THE EDITOR 264

WILSON ORNITHOLOGICAL SOCIETY LIBRARY. BOOKS: LIST B-3 267

ORNITHOLOGICAL LITERATURE 269

Albert Wolfson (ed.), *Recent Studies in Avian Biology*, reviewed by S. Charles Kendeigh; Harvey I. Fisher and Donald C. Goodman, *The Myology of the Whooping Crane*, reviewed by Andrew J. Berger.



BREEDING MALES OF FOREST THRUSHES, from top to bottom:
Gray-cheeked Thrush *(Catharus minimus bicknelli)* from Essex County, New York
Olive-backed Thrush *(Catharus ustulatus swainsoni)* from Ulster County, New York
Hermit Thrush *(Catharus guttatus faxoni)* from Cattaraugus County, New York
Veery *(Catharus f. fuscescens)* from Essex County, New York
Wood Thrush *(Hylocichla mustelina)* from Tomkins County, New York

ADAPTIVE MODIFICATIONS AND ECOLOGICAL ISOLATING MECHANISMS IN THE THRUSH GENERA *CATHARUS* AND *HYLOCICHLA*

BY WILLIAM C. DILGER

CLOSELY-RELATED sympatric species, if they are to retain their sympatry, must develop mechanisms which enable them to surmount the detrimental effects of ecological competition. Lack (1949) and Gause (1934), for example, have expressed the idea that two species with identical requirements for existence cannot exist together in the same ecological niche. Experimental studies such as those conducted by Park (1948) on two species of flour beetles (*Tribolium*) support this idea.

When a species becomes divided by geographical barriers a certain amount of genetic change takes place in the then-isolated populations. What happens upon the subsequent contact of these populations depends upon the kind and amount of differentiation that has occurred. The two populations can continue to live side by side in the same habitat if the differentiation that has taken place is in the nature of a certain amount of preadaptation for ecological and reproductive isolation. The initial preadaptations, if sufficient, become reinforced in both forms by the selective pressures applied to each by the other. Since these phenomena have been discussed at length by Mayr (1942:147) and Lack (1949), they will not be pursued further here.

The following discussion is an attempt to describe and evaluate the ecological isolating mechanisms operating in two genera of forest-inhabiting thrushes, *Catharus* and *Hylocichla*. The reproductive isolating mechanisms developed by these species have been described elsewhere (Dilger, 1956*a*).

The species dealt with here are the Wood Thrush (*Hylocichla mustelina*) and four other species of forest thrushes which formerly were placed in the same genus. The four now are considered congeneric with the nightingale-thrushes (*Catharus*) of Middle America (Dilger, 1956*b*). They are the Veery (*C. fuscescens*) and the Hermit (*C. guttatus*), Olive-backed (*C. ustulatus*) and Gray-cheeked (*C. minimus*) thrushes. The distributional ranges of these five species are roughly allopatric, extending across the forested portion of North America. There are extensive areas of sympatry, and as many as four species may occupy certain areas in the northeastern United States and southeastern Canada (Fig. 1).

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the aid of a number of people who contributed their efforts and materials in my behalf during the course of this investigation. Drs. Arthur A. Allen and Charles G. Sibley offered advice freely and provided a constant source of encouragement and enthusiasm.

Drs. W. Robert Eadie and LaMont C. Cole were most helpful regarding certain ecological aspects of the study. The latter also was of great aid in helping me with the statistical analysis of the data. Dr. Edgar M. Reilly, Jr., supplied the data from which the range maps were drawn. The hospitality of Dr. and Mrs. Stephen W. Eaton allowed me to pursue my studies, particularly of *C. ustulatus*, with greater ease and comfort than otherwise would have been possible. My wife, Martha, was of great assistance in helping with the statistical computations.

I am indebted to the following persons and institutions who kindly loaned materials and/or compiled certain data for me: Dr. Herbert Friedmann (United States National Museum), W. Earl Godfrey (National Museum of Canada), James C. Greenway, Jr. (Museum of Comparative Zoology, Harvard University), Drs. Alden H. Miller and Frank A. Pitelka (Museum of Vertebrate Zoology at the University of California), Dr. Austin L. Rand (Chicago Museum of Natural History), L. L. Snyder (Royal Ontario Museum), Dr. Harrison B. Tordoff (Museum of Natural History at the University of Kansas), Dr. Josselyn Van Tyne (Museum of Zoology, University of Michigan) and Drs. John T. Zimmer and Dean Amadon (American Museum of Natural History).

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Methods

The breeding seasons of 1952, 1953 and 1954 were devoted to field observation and to the accumulation of specimens. The field work was conducted in New York State, where all five of the forms breed. Two hundred and six skeletons representing *Hylocichla mustelina*, the four North American species of *Catharus* and the American Robin (*Turdus migratorius*) were examined and measured. Nearly one hundred other skeletons representing other species of *Catharus* and various additional turdine as well as saxicoline genera also were examined and measured. The collection of study skins at Cornell University was continually available.

Measurements of bones.—These were made with a dial caliper graduated in tenths of millimeters. The following are the measurements taken and the methods followed: The femur, tibiotarsus, tarsometatarsus, humerus, ulna, and manus (the entire hand from the proximal articular surface to the tip of the third digit) were measured across their greatest possible dimensions. This was accomplished by holding the bone perpendicularly between the faces of the caliper and sliding the caliper until it could go no further without damaging the bone. All the measurements listed above are believed to be reliable and free from instrumental error.

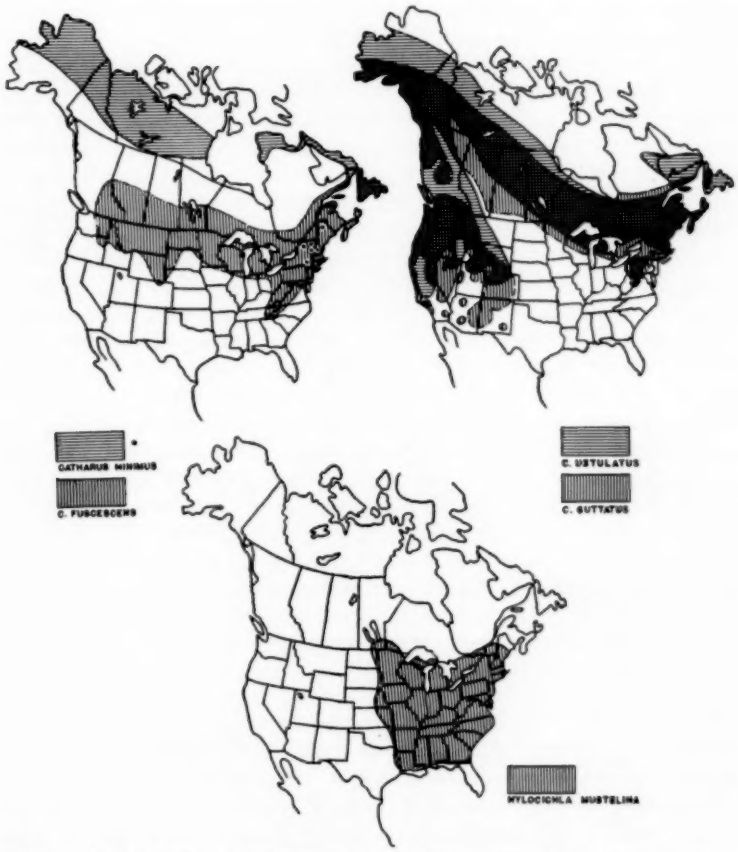


FIG. 1. Breeding ranges of *Catharus minimus, C. fuscescens, C. ustulatus, C. guttatus* and *Hylocichla mustelina.*

Several skull measurements were made as follows: the skull length was taken from the tip of the maxilla to the posteriormost portion of the cranium (just above the foramen magnum). The skull width was measured at the greatest width (between the auditory bullae). The skull width at lacrimals was taken as the greatest distance between the two lacrimals. The mandible was measured from its anterior tip to the posteriormost point of the condyle. The maxilla was measured from its anterior tip to the center of the crease of the naso-frontal hinge. The jaw width was measured between the

posterior points of the quadratojugals. The statistical analyses of these measurements are presented in Tables 1 to 5.

Weights.—Weights were accumulated for all of the species and subspecies in question. In order to minimize the error from seasonal fluctuations of weights only those of breeding males were utilized. The weights used were recorded to the nearest tenth of a gram and these data are summarized in Fig. 5.

Since the species being examined differed in absolute size, sometimes markedly, it was necessary to equate these measurements so that they could be compared directly. Body weight was used as an index to size and was employed as a measurement with which to equate the various bone measurements. The method proposed by Amadon (1943) was utilized. Since weights and measurements from the same individuals were not always obtainable, only the arithmetic means were compared. The procedure was to compute the cube root of the mean weight for each species and this figure was then divided into the mean skeletal measurements for each species. The various measurements thus were expressed as a proportion of body size. For ease of comparison these figures were further adjusted as percentages of the largest for each measurement of the same structure in different forms, the largest being regarded as 100 per cent.

Measurements of study skins.—Lengths of the tail and tarsus, and of the bill from the nostril were taken in the manner specified by Baldwin, Oberholser and Worley (1931). Measurements of the wing were taken as the chord of the closed (flattened) wing.

General Biology

Breeding Cycle.—The males arrive on the breeding grounds prior to the females and establish and defend territories against members of their own species. The females, upon arrival, seek out males of their own species and pair formation takes place (Dilger, 1956*a*). Nest building and incubation are performed by the female, but both parents help feed the young. The nests are typically rather bulky but neatly-constructed of twigs, grasses, mosses, leaf mold and leaves. Considerable mud is utilized by *H. mustelina*, the nests of which are similar to those made by the American Robin. All lay from three to five blue eggs, which are spotted with brownish in *C. ustulatus* and *C. minimus*. The eggs of *C. fuscescens* and *C. guttatus* are rarely spotted and, as far as is known, the eggs of *H. mustelina* are never spotted. The nests may be placed on the ground, as is typical of *C. guttatus* and *C. fuscescens* in the eastern part of their ranges, or they may be placed in trees or shrubs. Incubation requires about two weeks and fledging another two weeks.

Molts and Plumages.—The spotted young attain their first winter plumage

by a molt involving all but the flight feathers and a few pale-tipped scapulars or wing coverts. At this time the immature thrushes are indistinguishable from their parents except for the few remaining pale-tipped feathers. These are retained until the first post-nuptial molt. Once they are fully adult these birds are thought not to have any molt other than the annual post-nuptial, which is complete. There is a little evidence, however, that there may be at least a partial pre-nuptial molt. My captive thrushes had limited late-winter molts involving the crown, sides of the head and breast, back, rump and some of the wing coverts. This molt may have occurred because of the unnatural conditions imposed upon the birds by captivity. It is interesting to note, however, that these molts were symmetrical and always the same. It is also interesting that the breeding plumage in all these species is noticeably grayer than the warmer-toned winter plumage. The difference is thought to be due to feather wear. The new feathers acquired by these captives in the late winter or early spring were much grayer than the ones they had grown the previous autumn. Partial pre-nuptial molts have been described for several Old World species of thrushes (Witherby *et al.*, 1943). The question of whether or not *Hylocichla* and *Catharus* have at least a partial pre-nuptial molt is still unsolved. Dr. Kenneth C. Parkes kindly examined specimens in the Carnegie Museum taken on their wintering grounds and found no evidence of a pre-nuptial molt.

Feeding and Food.—All the thrushes considered are forest inhabitants, feeding largely on the forest floor. Food is obtained by flipping aside the débris of the forest floor with the bill, and progression on the ground is by means of long, springing hops. The feet are not used for scratching aside the débris as in some other birds utilizing similar environments. All these thrushes eat considerable amounts of vegetable matter, principally small fruits. The animal food consists mostly of small invertebrates, such as beetles, ants, and spiders. Small vertebrates, such as tiny frogs and salamanders, are sometimes utilized. Quite a bit of flycatching and foraging in foliage also are done, particularly by *C. fuscescens* and *C. ustulatus*.

More detailed information on the general biology of these forms is presented by Bent (1949).

Habitat Preferences

Dr. Herbert Caswell and I, using Cole's (1949) method for the analysis of interspecific association, have arrived at some figures indicating the degree of association of these thrushes with various habitats. The results for the species under consideration are summarized in Figure 2. The sources of data for these computations were habitat-specific breeding-bird censuses taken mainly from *Audubon Field Notes*. About 500 censuses were utilized in this investigation. A scale of from minus 1 to plus 1 was used to

	UC	DC	FA	DD	UD
H	-.50	-.69	-.48	+.16	+.41
CF	+.06	+.24	-.90	+.12	-.01
CG	+.29	+.28	-1.0	-.07	-.31
CU	+.47	+.12	-1.0	-.41	-.56
CM	?+.80	?+.50	-1.0	-1.0	-1.0

	CM	CU	CG	CF	H
CM	+1.0	?+.30	?-.70	-1.0	-1.0
CU		+1.0	+.75	+.23	-.35
CG			+1.0	+.56	-.41
CF				+1.0	-.08
H					+1.0

FIG. 2. (Left) Coefficients of association of *Hylocichla mustelina* and the North American species of *Catharus* with habitats in eastern North America. H = *Hylocichla mustelina*, CF = *Catharus f. fuscescens*, CG = *C. guttatus faxoni*, CU = *C. ustulatus swainsoni*, and CM = *C. minimus bicknelli*. UC = undisturbed coniferous, DC = disturbed coniferous, FA = farmland, DD = disturbed deciduous, and UD = undisturbed deciduous. Plus 1 = complete association, zero = association expected by chance alone, and minus 1, complete negative association. See text for further explanation.

FIG. 3. (Right) Coefficients of association among *Hylocichla mustelina* and the four North American species of *Catharus*. These figures are based on the total range of each species in eastern North America. Key to species and the scale of values used are the same as in Fig. 2. See text for further explanation.

express these various associations. Minus 1 indicates that the form and habitat under consideration are found together the minimum number of times possible for the data available. Zero indicates the amount of association one would expect by chance alone. Plus 1 indicates the highest association possible. A detailed report of this work on these forms and others of North America will be published separately by Caswell.

Hylocichla mustelina.—An abundance of sapling growth is apparently associated with optimum conditions for this species. Wood Thrushes tend to avoid the drier habitats and are most abundant in edge situations associated with hardwood forests. Weaver (*in* Bent, 1949) mentions that this species is showing a growing tendency to occupy suburban areas, a trend that had its beginnings about 1890. The suburban areas occupied are mostly edges of hardwood forests and it is not surprising that this species is taking advantage of this type of man-made habitat, much as the American Robin did earlier. In addition to its beginning to expand into suburban habitats, the Wood Thrush is steadily pushing its range northward, but it is still weakly associated with coniferous situations (—.50 for undisturbed coniferous forests and —.69 for disturbed coniferous habitats). The Wood Thrush is most strongly associated with undisturbed deciduous woodland

(+.41). It must be kept in mind that, for the most part, edge situations in these habitats are utilized.

Catharus f. fuscescens.—This subspecies of the Veery reaches its greatest concentrations in rather damp areas, either deciduous or coniferous. Moist bottomland woods with a lush understory of ferns and other plants seem to provide optimum conditions. The densest concentration of the Veery of which I am aware is one reported by Harding (1925). She found a three-acre area containing 12 pairs at Lake Asquam, New Hampshire. This area was a forested hillside fronting on the lake and covered with a dense understory of laurel (*Kalmia latifolia*). She does not mention the presence of any other thrushes. Our analysis showed that the greatest associations of the Veery were with disturbed deciduous (+.12) and disturbed coniferous (+.24) forests. The undisturbed habitats probably do not usually contain a dense enough understory for this species.

Catharus guttatus faxoni.—This subspecies of the Hermit Thrush is associated with edge type situations within forested areas. It is most often found along the margins of old burns, fire lanes, power line cuts, margins of lakes, and bogs, rather than the "exterior" edge situations inhabited by *H. mustelina*. The greatest concentrations of this species are associated with a rather dense, young, mixed coniferous-deciduous growth in the above areas. This thrush is much more tolerant of rather dry habitats than are its close relatives, although it is also frequently found in rather damp habitats. The Hermit Thrush is more closely associated with coniferous woodlands and mixed conifers and hardwoods than with pure deciduous woodland. It is most abundant in the proper habitats within coniferous woods, both disturbed (+.28) and undisturbed (+.29).

Catharus ustulatus swainsoni.—This form of the Olive-backed Thrush is most closely associated with undisturbed coniferous forests (+.47), although mixed forests appear acceptable, especially in the southern parts of its range. In mountainous areas in New York State it occurs from the mixed hardwoods (beech, maple, hemlock) upward into the mature forests of red spruce and balsam-fir. The presence of some conifers seems to be a necessity, for nest sites usually are located in them.

Catharus minimus bicknelli.—This is the most habitat-specific of the forms studied. In New York State it is confined, as a breeding bird, to the cloud-drenched, stunted fir and spruce tangles of mountain tops. It occurs at lower altitudes farther north but the habitat is similar. The substrate, where almost all of the foraging is done, is composed of a deep tangle of limbs and trunks in all stages of decomposition, and the whole is clothed with a sodden blanket of *Sphagnum*, other mosses and small herbaceous plants. The dense coniferous tangles provide deep shade on

the ground even on the brightest days. Unfortunately the number of censuses containing the Gray-cheeked Thrush do not permit a reliable statistical analysis of its habitat associations. However, in view of the statements presented above, its association with coniferous forests of this particular type must be in the neighborhood of +1.

Ecological Isolating Mechanisms

It is apparent that the greatest competition should exist among individuals of the same species. This seems logical because members of the same species are most similar in their requirements. Various mechanisms that tend to reduce the adverse effects of intraspecific competition have evolved. Behavior patterns associated with territoriality (breeding territory, individual distance and other hostile behavioral patterns) have evolved which permit an equable intraspecific distribution throughout a favorable environment. Differential adaptations of body size and/or size of the bill between the sexes may evolve, and these differences may serve to reduce the amount of intraspecific competition (Rand, 1952). Such differences may also become secondarily involved in sexual recognition. All of these adaptations permit maximum use of the suitable environment by the species population and insure maximum abundance and reproduction of individuals.

There is an ever-present tendency for animals to occupy more of the immediately-available environment, and the range inhabited by a form at any given time is the resultant between the forces tending to permit the form to spread and the forces opposing its spread. The genetic variability of any species tends to permit preadaptations to occur in varying degrees and frequencies. These preadaptations may serve in multitudinous ways, such as permitting higher reproductive rate, the utilization of different foods, or greater tolerance for the various aspects of the physical environment. The primary opposing factor is low genetic variability.

Likewise, the genetic variability of a species at any given time is mostly the resultant between environmental selective forces making for more precise adaptiveness to a particular niche (consequently reducing the variability) and the selective forces permitting expansion into adjacent niches (which tend to favor variability). Consequently, some species have narrower variability ("adaptive peaks") than do others. Among the forms presently under discussion, the Gray-cheeked Thrush provides the best example of a narrow adaptive peak, which is a reflection of its highly specialized existence. The relatively small range of variability in the skull characters studied may be a manifestation of this (see Table 2). On the other hand, the Hermit Thrush is the best example, among those under discussion, showing a rather wide range of variability in the skull characters studied. This may be a reflection of its rather wide tolerances for habitats and food.

If the greatest competition is among individuals of the same species it follows that usually the next most serious competition would have come *originally* from individuals of a closely-related, sympatric form. These would have the next most similar genotypes and hence will have the next least differences in their requirements. Mechanisms must be evolved in these cases to minimize the effects of what must otherwise be rather severe competition, especially for food. The very existence of adaptive differences among closely-related, sympatric forms suggests that such forms usually do compete severely enough to initiate selective pressures bringing about adaptive differences. The selective pressures must be supplied by each of the different species to all of the others in competition with it. It would seem that these selective pressures must also be proportional to the amount of competition; the greater the competition, the greater the selective pressures. The selective pressures should gradually dwindle as the adaptive modifications become progressively more effective. Forms more distantly related may also tend to compete if a convergence in requirements is taking place. Here, again, isolating mechanisms must develop if the two forms are to continue to exist sympatrically.

Food is apparently one of the most important single factors involved in competitive situations. This has been borne out in ecological studies (such as that of Lack, 1949). Many of the adaptive differences arising between competing forms seem to have a direct bearing on allowing the differential taking of foods, either different kinds of foods in the same environment or similar foods in different environments. Many closely-related, sympatric forms have diverged markedly in size, enabling them to minimize the competition for food by permitting the taking of different foods because of this size difference. One of the most familiar examples of this phenomenon is provided by the relatively large Hairy Woodpecker (*Dendrocopos villosus*) and the smaller Downy Woodpecker (*D. pubescens*). These two species are very similar in appearance and habits but differ chiefly in body size and in the relative size of their bills. Another example is found in the hawks of the genus *Accipiter*, the larger Cooper Hawk (*A. cooperi*) and the smaller Sharp-shinned Hawk (*A. striatus*). These two species also differ mainly in size and, in addition, there is a strong sexual disparity in size which no doubt helps to reduce the intraspecific competition (Storer, 1952:284).

Another mechanism allowing the differential taking of foods is a divergence in the size and/or the proportions of the bill. A classic example of this may be seen in the Galapagos finches of the genus *Geospiza* (Lack, 1947). This mechanism, too, may work to reduce intraspecific competition. Many species of birds have a marked sexual difference in the size and/or proportions of the bill. Probably the most extreme case is that of

the extinct Huia (*Heterolocha acutirostris*) of New Zealand, discussed by Lack (1947:155). The bill of the male was rather stout and short while that of the female was very long, slender and decurved. The males foraged by tearing open rotten logs for the invertebrate life within and the females followed them, able to utilize the food found in the deeper burrows and crevices by virtue of their remarkable bills. Of course, these are but a couple of the mechanisms utilized by birds to avoid ecological competition, but others exist and they undoubtedly exist in various combinations and degrees of divergence.

There is evidence to show that the divergence, presumably partly in response to competition, may be most marked in areas of sympatric occurrence and less evident in areas of solitary occurrence. Two species of rock nuthatches studied by Vaurie (1951) furnish an example. The two species, *Sitta neumayer* and *S. tephronota*, have rather wide distributions in western Asia and with a considerable area of sympatry. *Sitta tephronota* has a slightly larger bill than has *S. neumayer*, but in the area of sympatry this size difference is greatly enhanced. These two species appear to be very similar and this difference in bill size has been evolved, presumably resulting in minimizing the adverse effects of competition for food in the overlap area.

The forms considered in the present study, except for *H. mustelina*, are all closely related and demonstrate a high degree of sympatry. Since their sizes, foraging behavior and general biology are so similar it seems likely that there must have been a relatively great amount of interspecific competition for food during the period of initial contact of these forms. The ecological isolating mechanisms which must have developed in this situation are not immediately apparent.

It would seem likely that the amount of divergence that has taken place must be in proportion to the amount of competition among the various forms in the same environment. Dr. Herbert Caswell and I have measured the amounts of interspecific association in a number of North American bird species, including the present forms, by use of the method of measurement of interspecific association proposed by Cole (1949). The resulting coefficients of association are shown in Figure 3. The figures are based on the same scale as the species-habitat coefficients discussed earlier. These coefficients are based on the total breeding ranges of the species as they occur in eastern North America. If the coefficients were based on the overlap areas only, the figures would be much higher. About 500 censuses were utilized for this work. The above coefficients of association coincide very nicely with the amounts of divergence found to be associated with ecological isolating mechanisms.

An attempt was made to compute the coefficients of association for the

overlap areas but this was not feasible because of a lack of sufficient data from many areas. Coefficients of association were computed, however, for broad, roughly latitudinal bands which somewhat approximate the distributions of these thrushes (Fig. 4). These values give some interesting results but break down, especially in the southern parts of their ranges, because of the irregular distributions effected by the eastern mountains and by the paucity of breeding bird censuses in some critical areas. With these limitations in mind it may be seen that these latitudinal coefficients of association are about what one would expect from an examination of the breeding ranges and the total range coefficients.

The initial attempts to gain some knowledge of the ecological isolating mechanisms that must be in operation consisted of watching foraging individuals of all five species on their breeding grounds. Aside from the quite evident propensity of some forms for feeding largely at or near the edge and of others for feeding largely in the interior of the woodland, different strata appeared to be used in foraging. All the species fed commonly on the forest floor but those that did so most frequently were the Wood, Hermit, and Grey-cheeked thrushes. The Veery and, especially, the Olive-backed Thrush fed more often in the foliage and engaged in frequent flycatching. It is interesting to note that the three predominant ground feeders alternate with the two arboreal foragers in a north-south sequence, and that the edge foragers alternate with the interior foragers, except for *C. minimus* which is an interior forager.

Others have noticed these apparent differences in foraging levels. Francis H. Allen (*in* Bent, 1949:223) watched a Wood Thrush and a Veery foraging in the same vicinity and noted that "while the wood thrush hopped along in the manner of a robin, more or less, the veery was continually flitting from a perch in a bush or tree (2 to 4 feet from the ground) down to the ground, where he picked up an insect or something of the kind, and then again to another perch." This seems to be very typical *fuscescens* behavior. In addition, they are more frequently seen "flycatching" while foraging in this manner than are the others with the exception of the Olive-backed Thrush, the most inveterate flycatcher of them all. Bent (1949:176) says of that species: "They come with the warblers and other late migrants, and, like the warblers, they are often seen in the tree tops, feeding on insects in the opening foliage." This tree-top foraging behavior, as mentioned above, is by no means confined to migration but is the usual feeding behavior on the breeding grounds as well. The colloquial names of "Flycatching Thrush" and "Mosquito Thrush" reflect a general observance of this frequently-used feeding method.

Summarizing these observations, it would seem that *H. mustelina* and *C.*

	CU	CG	CF	H
CU	+1.0	+.86	+.25	
CG		+1.0	+.20	
CF			+1.0	
H				

A

	CU	CG	CF	H
CU	+1.0	+.33	−.66	+.08
CG		+1.0	+.47	+.37
CF			+1.0	+.54
H				+1.0

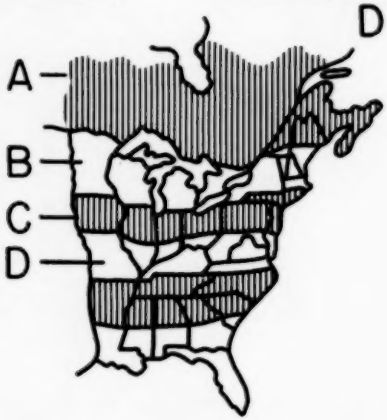
B

	CU	CG	CF	H
CU				
CG		+1.0	+.73	+.57
CF			+1.0	+.47
H				+1.0

C

	CU	CG	CF	H
CU	+1.0	+.89	+.88	−.08
CG		+1.0	+.67	−.30
CF			+1.0	+.05
H				+1.0

D



guttatus faxoni are mainly ground feeders at edge type situations, that *C. f. fuscescens* and *C. ustulatus swainsoni* are primarily arboreal foragers of interior situations and that *C. minimus bicknelli* is a ground forager in the interior of the forest.

Adaptations for Foraging

Some method of analysis was sought that would demonstrate any adaptive differences and supply a test for the validity of these subjective field observations. Two methods of approach were considered. It was reasoned that if this seeming difference between ground feeding and arboreal feeding were a real one, then there should be detectable adaptive differences in the bills and in the limbs consistent with the different habits. It was also reasoned that a detailed analysis of the contents of a number of stomachs of the various species should show something about the place of capture of the insects they contained.

Stomach Contents.—Hundreds of stomachs of these species have been investigated but, unfortunately, none ever was analysed carefully enough to gain much insight as to the ecology of the food organisms it contained. A notation of "beetles, 12 per cent" does not give one any idea whether the beetles in question were arboreal or terrestrial forms. Beal reported (Bent, 1949:152, 181) on the analysis of 551 stomachs of *C. guttatus faxoni* and 403 stomachs of *C. ustulatus swainsoni*; these represent birds taken in every month of the year. His data suggest that their foraging sites differ. Diptera, for example, were represented as 3.02 per cent of the diet of *C. guttatus faxoni* and 6.23 per cent of the diet of *C. ustulatus swainsoni*; Orthoptera comprised 6.32 per cent of the diet of *C. guttatus faxoni* but only 2.42 per cent of the diet of *C. ustulatus swainsoni*. Likewise, the percentage representation of spiders and millipedes for the Hermit Thrush was 7.47, while for the Olive-backed Thrush it was but 2.22. These figures are certainly suggestive of where the birds did much of their foraging but a careful detailed analysis of a large number of stomachs from all five species would still be desirable in order to gain a more accurate impression of their respective food habits.

Hind Limb Adaptations.—A number of skeletons of all five species concerned in this study were examined and measured along with those of the Russet Nightingale-thrush (*C. o. occidentalis*) and the American Robin. Special attention was paid to features that were likely to demonstrate adaptive

Fig. 4. (opposite) Coefficients of association among *Catharus ustulatus*, *C. guttatus*, *C. fuscescens*, and *Hylocichla mustelina* based on mutual occurrence within each of four latitudinal belts (A, B, C, and D). Open square in upper left of each box indicates that figure is not statistically significant, while solid square indicates significance. Key as in Figure 2. See text for further discussion.

modifications in respect to food getting, principally the bills and hind limbs. It was hoped that analysis might reveal some adaptive modifications consistent with what had been learned about the differential feeding habits of these forms. It is well known that limb lengths and the proportions of the component segments vary with the use to which they are adapted. Cursorial birds, for example have relatively longer legs than do arboreal ones. Not only do the relative lengths vary but cursorial forms tend to have relatively shorter femurs and relatively longer tarsometatarsi than do the arboreal forms. This is easy to demonstrate by the examination of two extreme forms; a ground-foraging thrush, such as *C. minimus*, and an aerial bird such as the Chimney Swift (*Chaetura pelagica*). Of course, extreme differences such as these were not expected upon examining the limb lengths and proportions of the forest thrushes but it was hoped that some detectable trend toward

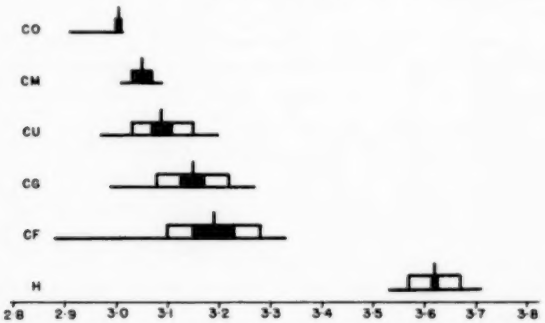


FIG. 5. Statistical analysis of the cube roots of weights in grams of breeding males of *Catharus* and *Hylocichla* species. CO = *Catharus o. occidentalis*; other symbols as in Figure 2. The horizontal line indicates the range, the vertical line, the mean, the black rectangle, two standard errors on either side of the mean, and the open rectangle, one standard deviation on either side of the mean.

arboreal proportions might be revealed in *C. fuscescens* and *C. ustulatus*. Indeed this is shown by the relatively-shorter tarsometatarsus in those two species (see Tables 1 and 2 and Figures 6 and 7).

The method used to equate the measurements of various appendages to body weight was discussed earlier. The weights of the several species of thrushes are compared graphically in Figure 5, and the various equated measurements appear in Tables 1 to 5.

In most cases the differences between the mean measurements of critical structures were readily evident without utilization of the equating procedure. However, it is felt that the equated measurements give a more

TABLE 1

MEASUREMENTS OF THE HIND LIMB ELEMENTS IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			FEMUR				
H. mustelina	21	22.60–24.60	23.50±.11	.51	2.17	6.4913	94.53
C. fuscescens	20	19.90–22.10	21.27±.13	.59	2.77	6.6750	97.20
C. guttatus	14	19.00–21.80	20.36±.19	.74	3.14	6.4565	94.02
C. ustulatus	21	19.50–21.40	20.28±.11	.51	2.51	6.5550	95.45
C. minimus	4	20.50–21.00	20.65±.12	.24	1.16	6.7691	98.57
C. occidentalis	4	20.20–20.90	20.48±.15	.31	1.51	6.8676	100.00
T. migratorius	12	26.50–28.20	27.34±.17	.59	2.16	6.3927	93.09
			TIBIOTARSUS				
H. mustelina	20	40.00–44.20	42.10±.25	1.09	2.59	11.6291	86.31
C. fuscescens	20	37.80–40.50	39.39±.29	1.00	2.54	12.3615	91.75
C. guttatus	12	37.70–40.60	39.04±.27	.94	2.40	12.3802	91.88
C. ustulatus	11	36.00–38.40	36.97±.20	.66	1.79	11.9497	88.69
C. minimus	4	38.60–38.90	38.78±.06	.12	.31	12.7122	94.35
C. occidentalis	5	39.20–41.20	40.18±.40	.87	2.11	13.4737	100.00
T. migratorius	12	45.50–49.10	46.98±.28	.98	2.09	10.9848	81.53
			TARSOMETATARSUS				
H. mustelina	22	29.70–34.10	31.10±.23	1.00	3.21	8.5906	78.22
C. fuscescens	18	27.50–31.50	30.04±.21	.88	2.93	9.4273	85.84
C. guttatus	12	28.80–32.00	30.08±.21	.75	2.16	9.5389	86.85
C. ustulatus	13	26.00–29.60	27.58±.21	.76	2.76	8.9146	81.17
C. minimus	5	28.80–30.90	30.04±.37	.83	2.76	9.8472	89.66
C. occidentalis	6	30.70–34.80	32.75±.67	1.67	4.89	10.9821	100.00
T. migratorius	12	32.00–34.80	33.05±.30	1.03	3.12	7.7277	70.36

[1]Actual measurement divided by cube root of body weight (see text).

accurate picture of the adaptive differences than do the unadjusted data.

All of the forms considered here are primarily adapted for ground foraging and the proportions and lengths of their legs are consistent with this mode of feeding. An apparent discrepancy is found in *H. mustelina*, which is terrestrial in habit although it has a relatively short tarsometatarsus (Fig. 7). The American Robin and other species of *Turdus* are mainly cursorial and also have relatively short tarsometatarsi as compared to *Catharus*. The limb proportions of *Turdus* and *Hylocichla* are clearly of the cursorial type but appear as if they both had been adapted from a common ancestor with a shorter tarsometatarsus than had the form from which *Catharus* was derived. In other words, a bigger step was involved in the selection for a more arboreally-adapted limb in *Catharus* than it would have been in the equally ground-adapted *Turdus* and *Hylocichla*.

TABLE 2

MEASUREMENTS OF THE SKULLS OF ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Coefficient of variation: Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			SKULL LENGTH				
H. mustelina	23	40.70–44.20	42.30±.23	1.45	3.43	11.6844	93.62
C. fuscescens	15	35.60–38.60	37.21±.26	.99	2.66	11.6773	93.56
C. guttatus	13	35.30–40.30	38.04±.35	1.34	3.52	12.0631	96.65
C. ustulatus	14	35.00–37.70	36.66±.19	.70	1.91	11.8495	94.94
C. minimus	6	36.10–37.80	36.80±.25	.61	1.66	12.0632	96.65
C. occidentalis	5	36.60–38.70	37.22±.41	.91	2.44	12.4811	100.00
T. migratorius	12	45.00–49.10	46.93±.33	1.15	2.45	10.9731	87.92
			SKULL WIDTH AT LACRYMALS				
H. mustelina	23	10.50–11.60	10.90±.07	.35	3.21	3.0108	97.23
C. fuscescens	17	9.00–10.50	9.76±.12	.51	5.23	3.0629	98.91
C. guttatus	14	8.90–10.00	9.56±.07	.25	2.61	3.0316	97.90
C. ustulatus	13	9.00–10.10	9.58±.09	.35	3.65	3.0965	100.00
C. minimus	6	8.80– 9.30	9.05±.08	.21	2.32	2.9660	95.80
C. occidentalis	5	8.50– 9.50	9.02±.18	.40	4.43	3.0247	97.68
T. migratorius	11	11.60–13.20	12.44±.16	.54	4.34	2.9087	93.93
			JAW WIDTH				
H. mustelina	23	13.40–16.60	15.10±.13	.61	4.04	4.1711	93.67
C. fuscescens	17	13.60–14.80	14.19±.08	.35	2.47	4.4531	100.00
C. guttatus	13	12.60–14.10	13.40±.10	.39	2.91	4.2493	95.42
C. ustulatus	12	12.60–14.60	13.67±.15	.53	3.88	4.4185	99.22
C. minimus	6	12.50–13.80	13.00±.21	.52	4.00	4.2615	95.70
C. occidentalis	5	12.60–13.60	13.06±.19	.42	3.22	4.3794	98.34
T. migratorius	12	15.50–18.40	17.26±.21	.72	4.17	4.0357	90.63

[1]Actual measurement divided by cube root of body weight (see text).

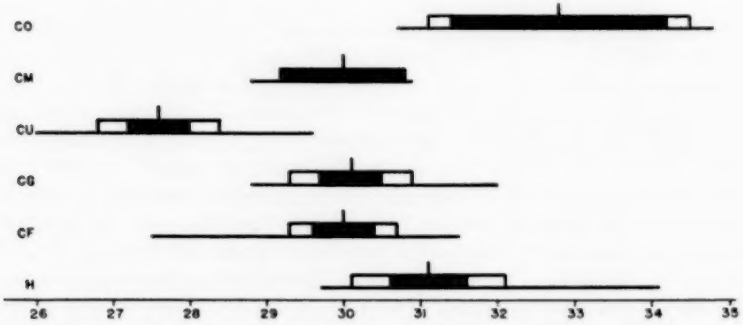


FIG. 6. Statistical analysis of the length (in millimeters) of the tarsometatarsus in adult male *Catharus* species and *Hylocichla mustelina*. Key as in Figure 5.

There are two other factors that have a bearing on length of limb in addition to the degree of ground- or arboreal-adaptiveness. Everything else being equal, a larger bird will tend to have a relatively shorter tarsometatarsus than will a smaller one. This is merely a reflection of the greater weight of the larger bird and the need for proportionately greater support. Gustav Kramer (pers. comm.) has found that condition among the corvids: the Raven (*Corvus corax*) has relatively shorter legs than has the smaller Fish Crow (*C. ossifragus*). The depth of the debris on the substrate upon which a bird forages also has a bearing on leg length. The greater the depth of the "clutter" in proportion to the size of the ground-foraging bird, the longer its legs must be if the bird is to move about efficiently. Whether or not the ground has a certain depth and density of debris also has a bearing upon whether a particular species walks or hops. Those species that forage on substrates that are deep and densely-tangled in proportion to their sizes must progress by hopping (*Catharus*, *Pipilo*, *Dumetella*, *Hylocichla*, *Melospiza*). Ground-foraging birds of relatively uncluttered substrates (for their sizes) walk (*Sturnus*, *Molothrus*, *Quiscalus*, *Anthus*, *Alauda*). The relatively-shorter tarsometatarsus of *Hylocichla mustelina* is probably due to the fact that it is larger than the *Catharus* species to which it is supposedly closely related and because it forages over substrates which are actually and relatively less-cluttered than those used by the *Catharus* species. Also, the Wood Thrush is probably most closely related to the genus *Turdus*, which is characterized by a short tarsometatarsus. The hopping motions of *Hylocichla* are much like those of *Turdus migratorius*, while those of the *Catharus* species are rather long and springing; this suggests that a relatively-longer tarsometatarsus may be associated with a greater mechanical advantage for long, high hops.

Among the forest thrushes considered, the non-migratory and ground-

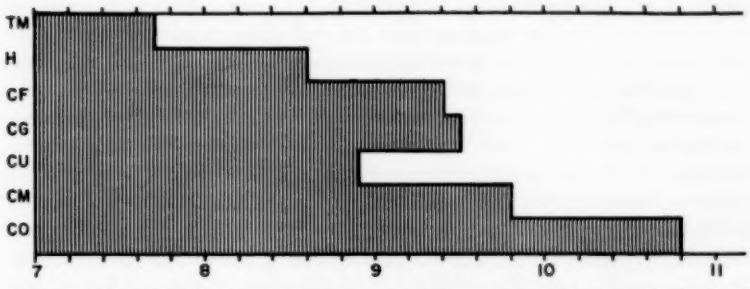


FIG. 7. Mean length of tarsometatarsus equated to mean cube root of the body weight in several species of thrushes. TM = *Turdus migratorius*; other symbols as in Figure 5.

dwelling Russet Nightingale-thrush (*C. occidentalis*) has the longest leg and also the longest segments of the leg. The next in order of modification for foraging on the ground is the Gray-cheeked Thrush, *C. minimus bicknelli*, and *C. guttatus faxoni* follows (see equated tarsometatarsus, Table 1). Observations in the field certainly bear this out. I have never seen *minimus* feeding anywhere but on the ground and it probably has to contend with a more-cluttered substrate, for its size, than does any of the others (see above under Habitat Preferences). The Hermit Thrush does some flycatching as well as foraging in trees and shrubs for small fruits, especially in the fall and winter. The remaining two species are the arboreal foragers and *fuscescens* is obviously not as highly adapted as *ustulatus* in this respect.

Apparently when a limb is becoming adapted for an arboreal mode of life the distal segment is the first to become shorter and the femur begins to adapt much later, or at least not as rapidly. The tarsometatarsus of the largely arboreal Olive-backed Thrush (*ustulatus*) has become more adapted for this mode of life than has the femur. The segment in most immediate contact with the environment is apparently the first one to experience modification due to selective pressures. It is apparent that the femur is becoming relatively longer both in *ustulatus* and *fuscescens*, but for some reason that of *fuscescens* is longer than that of *ustulatus*. I would have expected just the opposite condition. It may be that the limb proportions of *fuscescens* have had a different history than those of *ustulatus*. There is no reason to suppose that selection cannot proceed toward a more terrestrial-type limb, change to selection for an arboreal-type limb and reverse itself again, in various combinations of strengths and durations, depending on the vicissitudes of these selective pressures.

Perhaps the short tarsometatarsus of *H. mustelina* can be explained in a similar way, but it does not seem likely in view of the thoroughly-terrestrial habits of the Wood Thrush and the fact that *Turdus* and its close relatives are ground feeders for the most part and still have proportionately-shorter tarsometatarsi than do the species of *Catharus*. The femur is also relatively short in these latter forms. If there is a lag in femoral adaptation over tarsometatarsal adaptation, one would expect an arboreal form (with short tarsometatarsus and long femur), which is under selection favoring ground foraging, to develop a longer tarsometatarsus before the femur begins to shorten. This is not the case with the short-femured *mustelina*, which apparently was derived from terrestrial ancestors.

The long femur of *C. minimus bicknelli* can probably best be explained by taking into account the lengthening of the whole leg in response to the deeply cluttered substrate over which this small form feeds. The long femur of *C. occidentalis* can be explained in the same way.

TABLE 3

MEASUREMENTS OF MANDIBLE, MAXILLA AND BILL IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			MANDIBLE				
H. mustelina	22	32.00–35.60	33.20±.30	1.41	4.25	9.1707	96.19
C. fuscescens	15	26.90–30.50	28.85±.25	.98	3.40	9.0538	94.97
C. guttatus	14	26.00–32.40	29.12±.43	1.66	5.70	9.2344	96.86
C. ustulatus	12	26.50–28.70	28.07±.17	.58	2.07	9.0729	95.17
C. minimus	6	27.70–29.60	28.65±.28	.69	2.41	9.3915	98.51
C. occidentalis	4	27.50–29.80	28.43±.50	1.00	3.52	9.5336	100.00
T. migratorius	12	35.20–39.50	36.84±.41	1.43	3.88	8.6139	90.35
			MAXILLA				
H. mustelina	23	16.70–20.00	18.40±.18	.88	4.78	5.0825	95.32
C. fuscescens	15	15.10–17.00	16.09±.14	.56	3.48	5.0494	94.70
C. guttatus	12	15.10–18.00	16.49±.28	1.00	6.13	5.2292	98.07
C. ustulatus	13	14.20–16.30	15.27±.15	.56	3.67	4.9356	92.57
C. minimus	6	15.50–16.50	15.83±.15	.38	2.40	5.1891	97.32
C. occidentalis	5	15.20–16.80	15.90±.29	.66	4.15	5.3318	100.00
T. migratorius	12	20.00–22.90	21.05±.29	1.00	4.75	4.9219	92.31
			BILL FROM NOSTRIL				
H. mustelina	16	10.50–11.70	11.23±.10	.41	3.65	3.1020	98.93
C. fuscescens	17	8.70–10.40	9.58±.13	.53	5.53	3.0064	95.88
C. guttatus	16	9.50–10.80	9.84±.09	.38	3.86	3.1204	99.52
C. ustulatus	19	8.00– 9.50	8.67±.09	.39	4.49	2.8024	89.38
C. minimus	9	8.60– 9.40	9.10±.10	.30	3.30	2.9830	95.14
C. occidentalis	4	9.10–10.00	9.35±.21	.44	4.70	3.1354	100.00
T. migratorius	11	11.20–14.40	13.00±.26	.86	6.62	3.0396	96.94

[1]Actual measurement divided by cube root of body weight (see text).

Jaw Adaptations.—The bill tends to be longer and more slender in ground-foraging forms and shorter and wider in forms that forage in trees. A long, slender bill is a much better tool for flipping aside the debris of the forest floor and for probing into the crevices and cracks of this feeding niche than a shorter, stouter bill would be. Conversely, a relatively shorter and, especially, a wider bill would be of greater use in flycatching and for foraging in the foliage. A cursory comparison of the bills of a number of species that forage in the foliage and also indulge in flycatching will demonstrate this very nicely. Compare, for instance, the bills of the ground-foraging *Catharus* species and of *Turdus migratorius* with the bills of such arboreal feeders or flycatchers as the Red-eyed Vireo (*Vireo olivaceus*), Scarlet Tanager (*Piranga olivacea*) or the Eastern Wood Pewee (*Contopus virens*).

Various skull measurements were made for the species of *Catharus* and for *Hylocichla mustelina* and *Turdus migratorius* in order to detect any

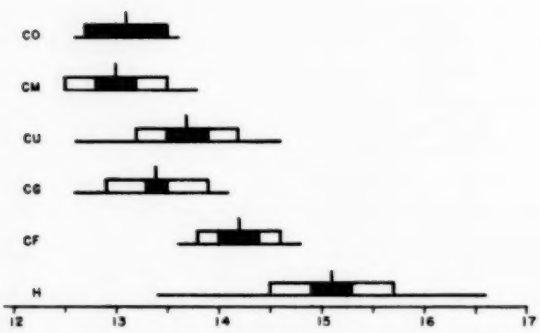


FIG. 8. Statistical analysis of the jaw width in adult males of *Catharus* species and *Hylocichla mustelina*. Symbols as in Figure 5.

drift toward shorter and wider bills in the more arboreal forms, *C. fuscescens* and *C. ustulatus*. The results of this investigation are summarized in Tables 1 through 5 and further in Figures 8 and 9. These measurements also were equated to the mean weights used as an index of body size. The necessity for equating the jaw measurements is not as clear as it was for the leg measurements. Bill proportions are not as intimately concerned with body size as are the proportions of the limbs. In any case, both the equated and unequated data (Table 2) show essentially the same pattern. The bills of *fuscescens* and *ustulatus* are both wider and shorter than are the bills of the more purely ground-foraging forms. Again, these differences in proportions are not extreme but they are significant statistically and they are consistent with what we know of the thrushes' feeding habits. The differences are demonstrated most clearly by comparisons of the maxilla length to the skull width at the lacrimals or the mandible length with the jaw width (Fig. 10).

It is of some interest that *C. ustulatus*, which is more arboreal than *fuscescens*, has a slightly narrower mouth than has *fuscescens*. Again, this is not what one would expect, but again we do not know the past history of adaptation in these forms. It may be that *fuscescens*, instead of progressing toward the arboreal feeding habit, is actually in the later stages of becoming secondarily adapted for ground feeding. The fact that it has a slightly longer femur, actually and relatively, than has *ustulatus* (see above) lends some credence to this idea.

Wing Adaptations.—The lengths and proportions of the segments of the wings follow the same pattern as was found in the hind limbs. Those forms utilizing their wings to the greatest extent have the longest distal segments (hands) and the shortest proximal segments (humeri). The converse is true

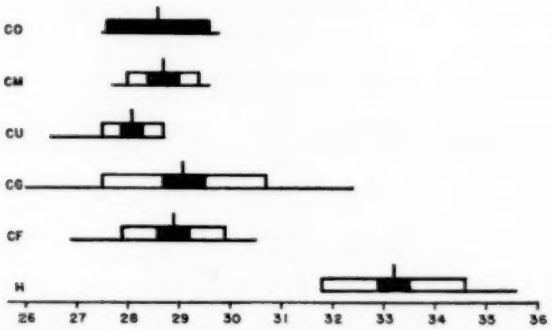


FIG. 9. Statistical analysis of mandible length in adult males of *Hylocichla mustelina* and *Catharus* species. Key as in Figure 5.

for the forms which use their wings the least. This is again easy to demonstrate by examining the wings of extreme examples, such as the wing of the Chimney Swift and the wing of a flightless bird such as the Kiwi (*Apteryx*). No such extreme differences as these are to be found among the thrushes studied, of course, but again there is modification in the direction consistent with their specific habits. It is not surprising that *Catharus occidentalis*, a non-migratory ground-forager, should have a wing least-adapted for sustained flight. The ground-dwelling, moderately-migratory Hermit Thrush also has a wing relatively poorly adapted for flying. The longest manus and the longest wing (measured from the wrist to the tip of longest primary) is found in *Catharus ustulatus*, a form which flies a great

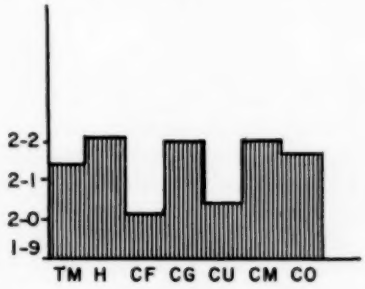


FIG. 10. Ratios of equated means of jaw width and mandible length (equated mandible length divided by equated jaw width) in several species of thrushes. The higher the ratio, the relatively longer and narrower the jaw. Key as in Figure 7. See text for further explanation.

TABLE 4

MEASUREMENTS OF THE WING ELEMENTS IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla, Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			HUMERUS				
H. mustelina	23	22.50–26.60	24.07±.16	.78	3.24	6.6489	98.50
C. fuscescens	18	20.70–22.20	21.24±.11	.46	2.17	6.6656	98.74
C. guttatus	16	19.40–21.80	20.59±.17	.69	3.35	6.5295	96.73
C. ustulatus	15	19.80–21.10	20.43±.09	.38	1.86	6.6035	97.82
C. minimus	5	19.30–20.60	19.92±.25	.55	2.76	6.5298	96.73
C. occidentalis	6	19.50–20.10	19.87±.10	.24	1.21	6.6630	98.71
T. migratorius	12	28.00–29.80	28.87±.19	.65	2.25	6.7503	100.00
			ULNA				
H. mustelina	23	28.30–31.10	29.76±.15	.75	2.52	8.2205	96.98
C. fuscescens	17	25.90–28.70	27.01±.19	.77	2.85	8.4763	100.00
C. guttatus	13	25.10–28.90	26.64±.27	1.08	4.05	8.4481	99.66
C. ustulatus	12	25.30–26.60	26.08±.11	.38	1.46	8.4298	99.45
C. minimus	5	23.30–26.00	24.22±.51	1.14	4.71	7.9394	93.66
C. occidentalis	5	23.50–23.70	23.56±.05	.11	.47	7.9004	93.20
T. migratorius	12	34.70–37.20	35.88±.27	.91	2.59	8.3894	98.97
			MANUS				
H. mustelina	21	24.70–27.40	26.16±.17	.81	3.09	7.2261	93.53
H. fuscescens	16	23.50–25.70	24.40±.15	.62	2.54	7.6573	99.12
C. guttatus	10	22.50–24.20	22.95±.10	.53	2.31	7.2778	94.20
C. ustulatus	11	22.40–24.90	23.90±.27	.91	3.81	7.7251	100.00
C. minimus	5	21.10–24.10	22.14±.52	1.18	5.33	7.2575	93.94
C. occidentalis	6	19.20–20.50	19.80±.19	.47	2.37	6.6396	85.94
T. migratorius	12	31.70–34.30	32.69±.21	.71	2.17	7.6435	98.94

[1]Actual measurement divided by cube root of body weight (see text).

deal while foraging in the tree tops and which has a very long migration route (Fig. 13). The other species also show the correlation between wing length and proportions when their flying habits are taken into consideration. One thing to keep in mind is that the wing length and manus length are not always perfectly correlated. All else being equal, a larger bird will have a proportionately longer manus in relation to the wing length than will a smaller bird. Gulls of the genus *Larus* have been investigated in this respect (Gustav Kramer, pers. comm.) and it has been found, for instance, that the Great Black-backed Gull (*L. marinus*) has a relatively longer manus than has the Herring Gull (*L. argentatus*). Equated wing length, therefore, probably is a better index of the amount of flying a bird does than is the manus length. Values for the equated wing lengths of a number of thrushes are presented in Table 5 and in Figure 13, and those for equated manus lengths

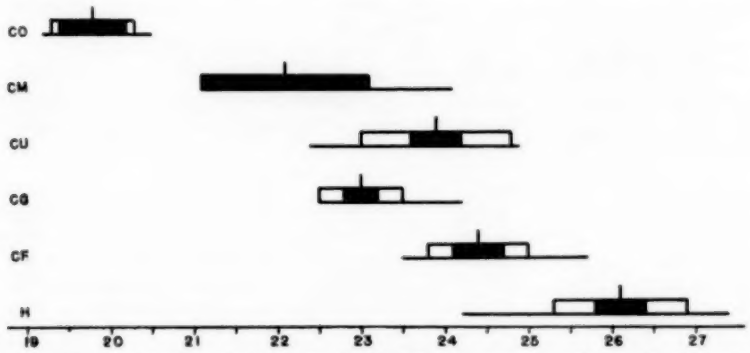
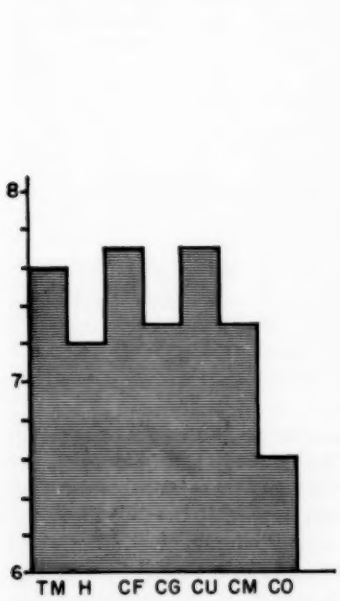


FIG. 11. Statistical analysis of the length of the manus in adult male *Catharus* species and *Hylocichla mustelina*. Key as in Figure 5.



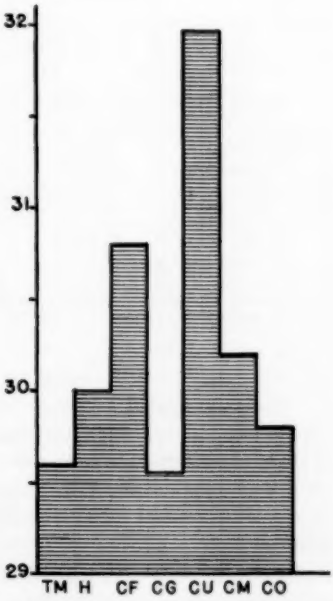


FIG. 12. (Left) Equated length of the manus in adult male *Turdus migratorius*, *Hylocichla mustelina* and *Catharus* species. Key as in Figure 7. Values were obtained by dividing the mean length by the mean cube root of the body weight.

FIG. 13. (Right) Equated wing length (wrist to tip of longest primary) in adult male thrushes. Key as in Figure 7.

TABLE 5

MEASUREMENTS OF THE WING, TAIL AND TARSUS IN ADULT MALE THRUSHES OF THE GENERA *Hylocichla*, *Catharus* AND *Turdus*

	Size of sample	Observed range	Mean with standard error	Standard deviation	Coefficient of variation	Equated value[1]	Per cent of largest
			WING				
H. mustelina	16	105–112	108.75± .53	2.12	1.95	30.0400	94.07
C. fuscescens	17	93–102	98.24± .60	2.51	2.55	30.8300	96.54
C. guttatus	16	88– 97	93.19± .88	2.79	2.99	29.5520	92.54
C. ustulatus	20	94–103	98.80± .51	2.28	2.31	31.9340	100.00
C. minimus	9	86– 97	92.20±1.23	3.70	4.01	30.0000	94.63
C. occidentalis	4	85– 91	88.80±1.32	2.60	2.93	29.7780	93.25
T. migratorius	11	123–132	126.64± .87	2.91	2.30	29.6110	92.72
			TAIL				
H. mustelina	16	64.30– 77.00	69.69± .78	3.13	4.49	19.2503	74.15
C. fuscescens	17	66.30– 73.50	70.13± .57	2.35	3.35	22.0084	84.78
C. guttatus	15	65.00– 71.50	68.23± .49	1.92	2.81	21.6369	83.35
C. ustulatus	20	62.10– 71.50	66.20± .57	2.55	3.85	21.3976	82.42
C. minimus	9	60.30– 69.30	64.88±1.08	3.24	4.99	21.2679	81.92
C. occidentalis	4	70.70– 81.50	77.40±2.34	4.68	2.93	25.9548	100.00
T. migratorius	11	92.50–101.90	96.81± .87	2.90	2.99	22.6361	87.19
			TARSUS				
H. mustelina	16	28.70–32.30	30.84±.25	1.00	3.24	8.5188	75.88
C. fuscescens	17	27.50–30.80	29.35±.32	1.32	4.50	9.2107	82.04
C. guttatus	16	28.40–30.80	29.78±.20	.82	2.75	9.4437	84.12
C. ustulatus	20	25.30–28.70	27.10±.16	.72	2.66	8.7594	78.02
C. minimus	9	27.00–30.70	28.90±.11	1.10	3.81	9.4735	84.38
C. occidentalis	4	32.60–34.60	33.48±.42	.84	2.51	11.2269	100.00
T. migratorius	11	31.50–33.60	32.57±.25	.82	2.52	7.6155	67.83

[1]Actual measurement divided by cube root of body weight (see text).

appear in Table 4 and Figure 12. Figure 11 contains a statistical comparison of the unequated manus measurements.

It is clear from this examination of characters of the wing that the proportions and lengths are as completely associated with the habits of the birds as are the lengths and proportions of the leg. Wing length, then, may be a poor index of general body size, even among closely-related forms. There also seems to be a tendency toward a more pointed wing in the better flyers and toward a more rounded one in birds whose flights are relatively infrequent and of short duration. The tenth primary in the *Catharus* species of South and Central America is much longer than that of the migratory forms breeding north of the Mexican border. Among the forms under consideration here, *C. guttatus* has the longest tenth primary and, as mentioned above, is the least migratory. Another genus of thrushes which has

both northern, migratory forms and southern, sedentary forms is *Turdus*. Northern, migratory species, such as *Turdus migratorius* and *T. iliacus*, have short tenth primaries and the southern, sedentary *T. nudigenis* and *T. jamaicensis* have longer ones. It appears that a shortening of the tenth primary is associated with the amount of flying done.

Habitat Association and Ecological Isolation

The coefficient of breeding-habitat association of *ustulatus* with *guttatus* (Fig. 3) is plus 0.75. Its association with *minimus* must be high, but the number of habitat-specific breeding-bird censuses that included *minimus* was too small for analysis. My own field observations indicate a high association of *ustulatus* with *minimus*. In all of the areas occupied by *minimus* there was a broad overlap with *ustulatus*. The only other species which has a positive association with *ustulatus* is *fuscescens* but this is slight, being plus 0.23.

The coefficients of association of *guttatus* with its near competitors are *guttatus* to *ustulatus*, plus 0.75 and *guttatus* to *fuscescens*, plus 0.56. There is some association of *guttatus* with *mustelina* but it is low, minus 0.41. This is less than one would expect from chance alone.

As mentioned above, we have no significant data on the association of *minimus*, but *ustulatus* is the only related species with which it is in regular contact.

The coefficients of association of *fuscescens* with its near relatives are *fuscescens* to *guttatus*, plus 0.56; *fuscescens* to *ustulatus*, plus 0.23 and *fuscescens* to *mustelina*, minus 0.08.

H. mustelina, despite its recent range expansion into more northerly regions, has no positive associations with any of the four species of *Catharus*. As might be expected, it is most weakly negative with *fuscescens*. Study of Figure 3 will help to summarize the information on coefficients of association among these species.

An examination of the above data, augmented with what we know of the ranges and habitats of these species, indicates that the two species with the strongest positive associations with near competitors are *Catharus ustulatus* and *C. guttatus*. Each has strong association with another adjacent form, *guttatus* with *fuscescens*, and *ustulatus* with *minimus*. The selective pressures toward adaptive modifications to minimize ecological competition must be strongest in these two forms. The results of this adaptive divergence are well marked at this time and these two forms are the most widely separated, as to niche, of the competing forms; *guttatus* is a bird of interior edges and forages on the ground while *ustulatus* is a bird of the forest interior, feeding largely in the trees. All four of these species of *Catharus* have achieved a maximum amount of adaptive radiation with a minimum of

biological "effort." All vary principally in whether they inhabit interior or edge situations, and whether they are arboreal or forage on the ground. By an alternate expression of these few variables, along with their intergrading habitat preferences, the four species have achieved a rather high degree of ecological isolation from one another (Table 6).

Apparently *ustulatus* has become adapted for a more arboreal foraging niche in response to selective pressures brought to bear upon it by *guttatus* and *minimus*. As has been pointed out, it now forages largely in the forest canopy where it seemingly is beginning to enter into some competition with the other arboreal foragers, such as the Scarlet Tanager (*Piranga olivacea*). The evidence for this is indirect. First, both of these species commonly feed in the canopy, are of about the same size, and take about the same types of food. Secondly, both species have a hostile call (Dilger, 1956*a*) which is very similar (the "chuck-burr" note). This would function as a "spacer" in this stratum much as do the intraspecific hostile displays characteristic of any species. These calls are very much alike in both species and it seems likely that innate releasing mechanisms have developed in both that permit response to either. Considering the great variety of vocalizations of which birds are capable it seems highly unlikely that two such similar calls would have developed in these partially-sympatric forms without some reciprocal selective pressures being responsible. When the degree of foliage-foraging in *ustulatus* is finally stabilized it seems likely that it will be the resultant between the pressures from above, from already long-established foliage foragers, and the pressure from below supplied by *guttatus* and *minimus*.

Since hostile movements and vocalizations that are mutually "understood" are of value in insuring an equable intraspecific distribution it would seem highly plausible that the degree of similarity and "understanding" of hostile displays in interspecific situations might provide clues as to the amounts of existing interspecific ecological competition. An investigation into this subject would be a worth-while contribution that a behaviorist might do well to conduct.

It would be of interest to make a quantitative study of the adaptive differences among these various species of *Catharus* both in areas of sympatry and in areas of lone occurrence. It would seem likely that these adaptive differences are enhanced in areas of contact and to a lesser extent in areas of lone occurrence, much after the fashion of the nuthatches studied by Vaurie (1951). Many more specimens than I had available would be required to demonstrate this. My material was collected from areas of sympatry and probably represents the extreme conditions of adaptive divergence in these forms. I would expect a clinal type of distribution in these

TABLE 6

SOME RELATIONSHIPS OF SPECIES ASSOCIATION, BILL STRUCTURE, FEEDING STATION AND HABITAT PREFERENCES IN THE THRUSH GENUS *Catharus*

Species	Coefficient of Species Association (see Fig. 3)	Difference Between Percentages of Equated: Maxillae	Jaw Widths	Feeding Station	Habitat
minimus	+.30	4.75	3.52	Ground (forest interior)	Undisturbed stunted coniferous (+.80?)
ustulatus	+.75	5.50	3.80	Largely arboreal (forest interior)	Undisturbed coniferous (+.47)
guttatus	+.56	3.37	4.58	Ground ("interior edges")	Undist. conif. (+.29) Undist. decid. (+.28)
fuscescens				Somewhat arboreal (forest interior)	Dist. conif. (+.24) Dist. decid. (+.12)

The species are arranged from top to bottom as they replace one another from north to south or from the top of a mountain to its base. The amount of actual association (overlap) is indicated by the association coefficient (see text). It is interesting to note that the two species with the highest association coefficient (*ustulatus* and *guttatus*) have the greatest differences in the percentages of equated maxilla length.

Species	Coefficient of Species Association (see Fig. 3)	Difference Between Percentages of Equated: Maxillae	Jaw Widths
minimus	—.70	.75	.38
guttatus			
ustulatus	+.23	2.13	.78
fuscescens			

The species have been arranged according to the least amounts of overlap and hence the low coefficient of association figures. Since these species do not overlap very much, their similarities are greater. Note the little difference between the percentages of equated maxillae and jaw widths. Even here, however, the species pair with the most overlap (*ustulatus* and *fuscescens*) have the greatest differences between the maxillae and jaw widths.

characters to occur, the regularity of which would depend on the quantitative abruptness of occurrence of competing forms.

This study was conducted in eastern United States where *Hylocichla mustelina* and all four North American species of *Catharus* occur. In the extreme western United States, only two species occur commonly, *ustulatus* and *guttatus*. Here they have apparently solved the problems of ecological competition in a somewhat different manner. I have insufficient data from these areas and was unable to borrow sufficient anatomical material for

critical comparisons. A study of the interrelations of *Catharus* in these areas would be interesting in comparison to the work reported here.

Summary

The very similar, roughly-allopatric, forest-inhabiting species of the thrush genera *Catharus* and *Hylocichla* often are found living beside one another in the areas of geographic overlap. Although each species differs somewhat in habitat, these habitats are shared with adjacent species, and differences in feeding niches have developed in response to selective pressures presumably stemming from competition for feeding areas.

The typical order of overlapping replacement from south to north or from lower altitudes to higher ones is *Hylocichla mustelina*, *Catharus fuscescens*, *C. guttatus*, *C. ustulatus* and *C. minimus*. The differences in feeding niches involve both the height at which foraging takes place and the location with respect to forest-edge or forest-interior sites. By a simple alternation of these places of foraging a maximum amount of ecological diversification is accomplished with a minimum amount of biological "effort" (Table 6). Adaptive modifications of the bill, hind limbs, and wings enable each species to occupy its specific feeding niche. A broader, shorter bill is associated with arboreal foraging and shorter legs accompanied by longer femurs and shorter tarsometatarsi are associated with arboreal feeding. Conversely, a longer, narrower bill and longer legs with shorter femurs and longer tarsometatarsi are associated with ground foraging. Longer, more pointed wings are associated with a greater amount of flying than are wings that are relatively shorter and more rounded. The Olive-backed Thrush, the most arboreal of the forms considered, has the longest wing in apparent response to the long migration route and also to the fact that it spends much of its time foraging in the foliage and in flycatching. The amounts of adaptive difference, in these respects, between the various pairs of species tend to be in direct proportion to the amounts of association between them. Coefficients of association were computed for the species by using habitat-specific breeding-bird censuses with Cole's (1949) method for the computation of interspecific association.

It is presumed that these species have achieved their ecological isolation by coming "rough sorted" as to habitat by virtue of their largely allopatric distributions and by developing differences in their feeding niches which allow them to occur sympatrically in the broad overlap areas.

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JANUARY 15, 1956.

MINIMUM SPACE REQUIREMENTS OF SOME NESTING PASSERINE BIRDS

BY JAMES R. BEER, LOUIS D. FRENZEL AND NORMAN HANSEN

MANY workers concerned with the problems involving home range and territorial behavior in vertebrates consider space to be one of the more important facets. It is believed that a minimum amount of space is required by an individual or pair before it will occupy an area even though the area may contain apparently adequate nesting cover, escape cover, food, song perches and other specific requirements for survival and perpetuation of the species.

The Quetico-Superior Wilderness Research Center provided facilities for us to conduct investigations on the ecology of the vertebrates found in the vicinity of Basswood Lake, Lake County, Minnesota. This is paper No. 3419 of the Scientific Journal Series from the Minnesota Agricultural Experiment Station, St. Paul 1, Minnesota. We here report on the data gathered on the space requirements, during the nesting season, of the Song Sparrow (*Melospiza melodia*), Yellow Warbler (*Dendroica petchia*) and the Red-eyed Vireo (*Vireo olivaceus*) during the six field seasons, 1950 to 1955, inclusive.

The Basswood Lake area, with its many islands (Fig. 1), is well suited to the study of the minimum area that birds require. Many of the islands are situated so that the birds resident thereon do not have ready access to the mainland or to other islands. On the islands where single pairs are found the physical and vegetational aspects are the factors determining minimum space needs, and social intolerance should be of little or no importance. There is no chance to expand the area defended or utilized at the expense of other pairs.

The original dominant vegetation was composed primarily of red, white and jack pines (*Pinus resinosa, P. strobus and P. banksiana*), white spruce (*Picea glauca*), balsam-fir (*Abies balsamea*), white birch (*Betula papyrifera*) in the uplands and black spruce (*Picea mariana*), tamarack (*Larix laricina*), white cedar (*Thuja occidentalis*) and black ash (*Fraxinus nigra*) in the swamps and wet areas (Rosendahl, 1955). The present vegetation on most of the islands shows the effects of logging and burning, with aspen (*Populus tremuloides*) and white birch now being the principal dominants, although some of the islands retain remnants of the original pine forest.

METHODS

The islands used in this study vary from a small fraction of one acre to about 15 acres in extent. They were chosen on the basis of size, availability, and the ease with which reasonably accurate observations could be

FIG. 1. Map of the Basswood Lake area, Minnesota. The islands on which bird populations were observed are blocked in and numbered.

made. The method of study was to make direct observations using sight and song records to determine the presence or absence of birds and to establish the number of pairs present. These observations were normally made early in the morning. Each island was visited on at least four different days during the breeding season. The maximum number of males found showing signs of stability (observed on two or more days and with behavior suggesting that they were in residence) was taken to be the number of nesting areas occupied. Rarely, verification of the presence of breeding birds was based on active nests even though the adults were neither heard nor seen. "Area per pair" as used here is based on dividing the area of the island (in acres) by the number of pairs present rather than extensive observations of the areas actually utilized or defended.

The Song Sparrow, Yellow Warbler, and Red-eyed Vireo were chosen for study because of their abundance and the ease with which observations could be made. They also normally obtain all of their requirements in a single continuous area. Each species utilizes a different level in the habitat and represents a different family of the Passeriformes.

Findings

Song Sparrow. The Song Sparrow is a bird of the brushy edges which are found along the borders of forest openings and the lake shores. The preferred habitat here appears to be a grassy opening with a border of low brush and shrubs between it and the lake. Nesting, while normally on the ground, may take place in holes in trees or in small evergreens as much as seven feet off the ground where there are not suitable open areas.

It has been shown by Nice (1937) that during the breeding season this sparrow normally maintains and uses an area of between 0.7 and 1.5 acres. Nice (1943:152) stated that in central Ohio "the minimum size of a territory was some 2000 square meters (1/2 acre); an average size in a region well filled with Song Sparrows was some 2700 square meters (2/3 of an acre), while a few might include 6000 square meters (1 1/2 acres). During later years when the population was comparatively small, Song Sparrows might range over a larger region than when Interpont was filled to capacity." These figures represent very detailed observations of a mainland area.

The present study indicates that under the specialized conditions found on small islands the minimum territory size for Song Sparrows may be considerably less than that recorded for mainland areas. An examination of Table 1 shows that the minimum area may be as low as 0.04 acres, about one-tenth of the minimum size reported by Nice. This figure is for the small islands occupied by a single pair.

That the use of such a small area is of regular occurrence is borne out by the fact that island no. 8 had nesting birds for six consecutive years (see Table 1). In two of these years we observed second nests as well as fledglings. Island no. 33, which is also about 0.04 acres in size, had a nesting pair during one of the two years in which observations were made. The area may be nearly as small when two pairs are present, since the smallest average area per pair for two pairs was found to be 0.05 acres. However, this situation was unusual in that it involved a dominant and a definitely subordinate male. The dominant bird appeared at times to occupy all of the island while the subordinate bird was seen only on one half of the area except when being chased by the dominant male. Both males were observed to sing but the subordinate male's song was much weaker than that of his competitor and often was not carried to its normal completion. Repeated observations showed that both pairs were successfully

TABLE 1

NUMBERS OF BREEDING PAIRS OF SONG SPARROWS ON THE ISLANDS IN BASSWOOD LAKE, MINNESOTA

Island No.	Pairs Observed						Greatest No. of pairs	Island area (acres)	Acres per pair
	1950	1951	1952	1953	1954	1955			
1	1	2	2	2	1	1	2	.33	.16
2	1	2	2	3	2	2	3	.9	.45
3	3	1	4	4	3	3	4	2.4	.60
4	1	1	1	3	1	2	3	2.6	.87
5A	1	1	1	3	1	2	3	1.2	.40
5B	1	0	0	1	0	.....	1	.1	.10
5C	1	0	0	.....	1	0	1	.2	.10
5D	1	0	0	.....	1	1	1	.2	.20
6	4	.....	1	2	0	0	4	4.0	1.0
7	1	0	0	0	0	1	1	.06	.06
8	1	1	1	1	1	1	1	.04	.04
9	1	.....	1	2	1	1	2	.1	.05
10	1	1	1	1	2	1	2	.2	.10
11	1	0	0	1	1	1	1	.1	.10
12	1	.....	.....	5	5	.....	5	9.3	1.96
13	1	.....	1	2	2	.....	2	2.3	1.15
14	1	.....	1	3	1	.....	3	4.1	1.4
15	1	.....	.....	.....	.....	.....	1	11.6	11.6
16	1	.....	1	1	1	0	1	.08	.08
17	1	.....	2	.....	2	2	2	.35	.17
18	2	1	1	3	1	2	3	.9	.30
19	1	.....	.....	.....	.....	.....	1	3.5	3.5
20	.....	.....	1	.....	.....	.....	1	11.6	11.6
22	.....	.....	.....	2	2	.....	2	1.4	.70
23	.....	.....	1	2	2	.....	2	3.1	1.55
24	.....	.....	.....	.....	1	.....	1	5.9	5.9
25	.....	.....	.....	.....	5	4	5	6.1	1.2
26	.....	1	.....	.....	5	.....	5	1.6	.52
28	.....	.....	.....	.....	1	.....	1	1.8	1.8
29	.....	.....	.....	.....	0	.....	0	2.4	.....
30	.....	.....	.....	.....	0	.....	0	2.7	.....
32	.....	.....	.....	.....	0	.....	0	2.8	.....
33	.....	.....	.....	.....	1	0	1	.04	.04
34	.....	.....	.....	.....	1	.....	1	.05	.05
35	.....	.....	.....	.....	0	.....	0	.06	.....
36	.....	.....	.....	.....	1	.....	1	.5	.5
37	.....	.....	.....	.....	1	.....	1	1.7	1.7
38	.....	.....	.....	.....	0	.....	0	1.0	.....
39	.....	.....	.....	.....	0	.....	0	18.6	.....

raising young. The next smallest area observed to have two pairs was an island of 0.2 acres, about twice the size of that discussed above. This island was cigar shaped, which undoubtedly helped to maintain a state of stability. When three pairs of Song Sparrows were present the smallest average area occupied per pair was about 0.3 acres. Minimum areas per pair of 0.6 and 0.5 acres were observed when four and five pairs were present. These last figures are not appreciably different from the minimum-sized areas of one-half acre reported by Nice (1943:152).

TABLE 2

NUMBERS OF BREEDING PAIRS OF YELLOW WARBLERS ON THE ISLANDS IN BASSWOOD LAKE, MINNESOTA

Island No.	Pairs Observed						Greatest No. of pairs	Island area (acres)	Acres per pair
	1950	1951	1952	1953	1954	1955			
1	1	2	0	1	1	0	2	.33	.16
2	2	1	1	3	2	1	3	.9	.3
3	1	.....	.....	0	3	.....	3	2.4	.8
4	1	.....	.....	1	0	.....	1	2.6	2.6
5A	.....	.....	.....	1	1	1	1	1.2	1.2
5B	.....	.....	.....	0	0	.....	0	.1	.....
5C	.....	.....	.....	0	0	0	0	.1	.....
5D	.....	.....	.....	0	0	0	0	.2	.....
6	.....	.....	.....	1	0	.....	1	4.0	4.0
7	0	.....	.....	0	0	0	0	.06	.....
8	0	0	0	0	0	0	0	.04	.....
9	.....	.....	1	0	1	1	1	.1	.1
10	.....	.....	.....	0	1	1	1	.2	.2
11	.....	.....	.....	0	1	.....	1	.1	.1
12	1	.....	.....	3	.....	3	3	9.3	3.1
13	1	.....	1	0	0	1	1	2.3	2.3
14	.....	.....	.....	2	0	.....	2	4.1	2.0
15	.....	.....	.....	4	.....	.....	4	11.6	2.9
16	.....	.....	1	0	1	1	1	.08	.08
17	.....	.....	.....	.....	0	0	0	.35	.....
18	.....	.....	1	1	2	2	2	.9	.5
22	.....	.....	.....	1	1	.....	1	1.4	1.4
23	.....	.....	.....	0	0	.....	0	3.1	.....
24	.....	.....	1	.....	5	.....	5	5.9	1.2
25	.....	.....	.....	.....	4	.....	4	6.1	1.5
26	.....	.....	.....	.....	5	.....	5	1.6	.3
28	.....	.....	.....	.....	1	.....	1	1.8	1.8
29	.....	.....	.....	.....	0	.....	0	2.4	.....
30	.....	.....	.....	.....	0	.....	0	2.7	.....
32	.....	.....	.....	.....	0	.....	0	2.8	.....
33	.....	.....	.....	.....	0	0	0	.04	.....
34	.....	.....	.....	.....	0	.....	0	.05	.....
35	.....	.....	.....	.....	0	.....	0	.06	.....
36	.....	.....	.....	.....	1	.....	1	.5	.5
37	.....	.....	.....	.....	2	.....	2	1.7	.8
38	.....	.....	.....	.....	0	.....	0	1.0	.....
39	.....	.....	.....	.....	0	.....	0	18.6	.....

Yellow Warbler. The Yellow Warbler is a bird of the brushlands, preferring to nest and to do much of its feeding in underbrush and low trees, especially where an edge is present. Kendeigh (1941:171) has suggested that the average size of Yellow Warbler territories is about 0.4 acres. However, the area studied by him in Iowa apparently lacked adequate feeding grounds, since the birds regularly left their territories in thickets of *Cephalanthus* to feed in the forest nearby. Some flew as far as 1200 feet to feed. We have no observations of Yellow Warblers leaving one of the islands to feed, although the less common Myrtle Warbler (*Dendroica coronata*) was observed to do so frequently. The map drawn by Kendeigh (1941)

shows that there is considerable variation in territory size but he did not give values for the maximum or minimum area. Differences in the two habitats make it difficult to compare the results of the two studies.

The smallest island observed to be occupied by a single pair of Yellow Warblers was about 0.08 acres in extent (see Table 2). Islands with two breeding pairs were not smaller than .33 acres, which allowed about 0.16 acres per pair. This is twice the minimum area per pair where only one pair was observed. For three or more pairs a minimum area of 0.3 acres each was observed. This figure agrees very well with the average figure given by Kendeigh (1941) but is three times as large as our minimum figure.

Red-Eyed Vireo. The habitat which the Red-eyed Vireo seems to favor is a broadleaved woodland with an undergrowth of brush and slender saplings. This situation gives the vireo a nesting site in the low undergrowth and a feeding area in the aspen and birch overstory. Lawrence (1953) and Kendeigh (1947:55–57) have shown that the space utilized by the Red-eyed Vireos on their study areas varied from 0.7 to 2.6 acres.

Singing males were observed on islands in Basswood Lake with areas as small as 0.08 acres. Although nests were not found, apparently-resident males were observed in two of the four years that we examined this island (island no. 16; see Table 3).

The smallest island upon which a Red-eyed Vireo's nest was found was island no. 1 which is 0.33 acres in extent. The smallest area per pair when two pairs were present was 0.4 acres. Nesting was not observed, although the singing males were observed consistently on the same song perches. When three pairs were present the smallest area per pair was 0.3 acres. An average area of 1.4 acres was available per pair when all three pairs were observed nesting. When four or five pairs were present the average available area was considerably larger—about 2.3 acres.

The smallest area observed when a single pair was present was about one-tenth the minimum observed on the mainland by Lawrence (1953) and Kendeigh (1947). When nesting was observed the smallest area was about 0.4 acres or about one-half the minimum observed by Kendeigh (1947) and Lawrence (1953). The average area available when four or five pairs were present approached the maximum figure of 2.6 acres determined by these workers. Of course some of the available area may not have been used, so that these figures may be larger than the areas actually utilized.

Discussion

The figures given on the space required, utilized, or available are averages of the number of pairs present divided into the area involved. Thus in some cases the actual minimum area may be considerably smaller than the one listed as used. Time limitations often made thorough search for nests

TABLE 3

NUMBERS OF BREEDING PAIRS OF RED-EYED VIREOS ON THE ISLANDS IN BASSWOOD LAKE, MINNESOTA

Island No.	Pairs Observed						Greatest No. of pairs	Island area (acres)	Acres per pair
	1950	1951	1952	1953	1954	1955			
1	1	0	1	1	0	0	1	.33	.33
2	1	1	1	3	1	2	3	.9	.3
3	1	1	1	1	0	1	1	2.4	2.4
4	1	1	.....	1	1	.....	1	2.6	2.6
5A	.....	.....	1	0	0	1	1	1.2	1.2
5B	.....	.....	.....	1	0	0	1	.1	.1
5C	.....	.....	.....	0	0	0	0	.1	.....
5D	.....	.....	.....	0	0	0	0	.2	.....
6	1	.....	.....	1	1	.....	1	4.0	4.0
7	0	0	0	0	0	0	0	.06	.....
8	0	0	0	0	0	0	0	.04	.....
9	.....	.....	.....	0	0	.....	0	.1	.....
10	.....	.....	1	0	0	.....	1	.2	.2
11	.....	.....	.....	1	0	0	1	.1	.1
12	1	.....	.....	3	4	.....	4	9.3	2.3
13	1	.....	1	0	0	.....	1	2.3	2.3
14	0	.....	1	3	1	.....	3	4.1	1.4
15	2	.....	.....	.....	5	.....	5	11.6	2.3
16	0	.....	.....	1	1	0	1	.08	.08
17	0	.....	.....	.....	0	0	0	.35	.....
18	.....	.....	1	2	1	.....	2	.9	.4
19	1	.....	.....	.....	.....	.....	1	3.5	3.5
20	1	.....	.....	.....	.....	.....	1	11.6	11.6
22	.....	.....	.....	0	0	.....	0	1.4	.....
23	.....	.....	.....	0	0	.....	0	3.1	.....
24	.....	.....	.....	.....	3	.....	3	5.9	2.0
25	.....	.....	.....	.....	1	2	2	6.1	3.0
26	.....	.....	.....	.....	0	.....	0	1.6	.....
28	.....	.....	.....	.....	0	.....	0	1.8	.....
29	.....	.....	.....	.....	0	.....	0	2.4	.....
30	.....	.....	.....	.....	0	.....	0	2.7	.....
32	.....	.....	.....	.....	0	.....	0	2.8	.....
33	.....	.....	.....	.....	0	0	0	.04	.....
34	.....	.....	.....	.....	0	.....	0	.05	.....
35	.....	.....	.....	.....	0	.....	0	.06	.....
36	.....	.....	.....	.....	0	.....	0	.5	.....
37	.....	.....	.....	.....	0	.....	0	1.7	.....
38	.....	.....	.....	.....	0	.....	0	1.0	.....
39	.....	.....	.....	.....	4	.....	4	18.6	4.6

impossible. No attempt was made to follow fledglings through to a stage of independence. Fledging is here considered to indicate that the area was adequate for the raising of young. However, some detailed data are available for some of the Song Sparrows found on the very small islands.

In the previous discussion it was shown that Song Sparrows which inhabit islands will utilize areas as small as one-tenth the minimum size defended by birds on the mainland and in contact with others of their own species. The Red-eyed Vireo was found on very small areas but the smallest island

TABLE 4

MINIMUM AREA IN ACRES PER PAIR AT DIFFERENT POPULATION LEVELS

No. of Pairs	Song Sparrow		Yellow Warbler		Red-eyed Vireo	
	All Observations	Nesting Observed	All Observations	Nesting Observed	All Observations	Nesting Observed
1	0.04	0.04	0.08	0.1	0.08	0.33
2	0.05	0.05	0.16	0.16	0.4	.....
3	0.30	0.30	0.30	.30	0.3	1.4
4	0.60	0.60	1.5	.....	2.3	2.3
5	0.52	1.20	0.3	.30	2.3	2.3

on which breeding was ascertained was about 0.33 acres. This is about one-half the minimum-sized area reported by Lawrence (1953) for mainland areas. On the other hand the smallest area utilized by the Yellow Warbler was 0.08 acres which is only about one-fifth the average of 0.4 acres given by Kendeigh (1941). However, this area is probably not much different than the minimum found by him.

In all three species the minimum area utilized increased with the number of pairs present until three to five pairs were present (Table 4). These values then were approximately the same as those reported from the mainland by other authors. We observed no cases of birds nesting on one island and feeding on (or including as part of their territories) parts of other islands or the mainland.

Many reasons for the spacing of pairs have been postulated. These include:

(1) it is necessary to have a certain amount of conflict in order to synchronize breeding;
(2) it ensures an adequate food supply for the young;
(3) it prevents the undue increase of the species;
(4) it offers protection from interference in the orderly sequence of the nesting cycle.

The first hypothesis, which suggests that it is necessary to have conflict in order to synchronize breeding within the population, appears to be quite workable with colonial sea birds but less so with non-colonial passerines. In the three species observed, the single pairs on small islands removed from direct contact with others of their own species appeared to be as successful as those nesting where there was considerable direct contact with their neighbors. There was of course a certain amount of indirect contact in that singing birds can be heard for considerable distances over the open water. This is especially true for the Red-eyed Vireo. However, it is difficult to see how this factor can be important with these species.

It has long been claimed that many birds limit their own breeding densities through territorial behavior, and thereby insure a food supply for themselves and their young. While the idea superficially is attractive, there is little

positive evidence in its favor. The data presented earlier suggest that the size of the territory normally chosen by these three species on mainland areas is not determined by the food supply. In the case of Song Sparrows, island areas may be as little as one-tenth of the minimum area utilized on the mainland. These islands often appear to be quite sterile and it is difficult to visualize their approaching the production of food per unit area characteristic of the area studied by Nice (1937; 1943) in central Ohio. Observations of Song Sparrows on island no. 8 have shown that this area is large enough to serve this purpose. Although it is but 0.04 acres in extent, at least one brood has been fledged there in each of the six years in which observations were made. In one year two broods were known to have been raised. This island is so well isolated that feeding is definitely limited to its surface. The data for the Red-eyed Vireo and Yellow Warbler are similar but not so well defined.

If the food supplies were the all-important factor and the territories were defended on this basis, the minimum area occupied as demonstrated on the islands should be about the same as the minimum area defended and utilized on the larger islands and on the mainland.

The third theory suggesting "that it prevents undue increase of the species" does not seem tenable because most species tend to fill all the vacant areas available. Predation, accident and other extrinsic causes normally eliminate any surplus birds.

The last suggestion that a territory offers protection from interference in the orderly sequence of the nesting cycle seems to be the nearest the truth. This of course covers many factors and actually only suggests that a territory during the breeding season helps the species reproduce itself. Mayr (1935) considered that pairing and mating functions are at the root of territorial behavior. This allows for the best utilization of the area by reproducing birds with the possibility of many factors being involved.

Conclusions

The data gathered indicate that in some birds the minimum amount of space used by a pair to raise their young successfully may be much smaller when the boundaries are strictly physical barriers rather than invisible lines determined by intraspecific conflict. The three species observed reacted similarly to the situation of reduced space. The Song Sparrow on occasion successfully utilized islands less than one-tenth the size of the minimum area reportedly required on the mainland. The Red-eyed Vireo and the Yellow Warbler showed similar but less pronounced tendencies. The size of a territory is based upon a number of factors and not on single factors such as food.

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ON CERTAIN CHARADRIIFORM BIRDS OF BAFFIN ISLAND

BY GEORGE M. SUTTON AND DAVID F. PARMELEE

THE preference many arctic birds show for grass tundra as a nesting ground is noted by Soper (1940), but he does not explain the preference. Of the grass tundra he says (p. 13): "Where this is boggy and sprinkled with ponds and small lakes, the breeding population of birds reaches the peak of abundance." Of the desert tundra he says (p. 19): "Practically, if not entirely absent over the greater part of these rocky sectors . . . will be . . . birds which are abundant as breeders on the grass tundra . . . especially . . . in close proximity to the sea."

Our observations in southern Baffin Island in the summer of 1953 support Soper's statements to a remarkable degree, especially with regard to charadriiform birds. Our headquarters were near the head of Frobisher Bay, at a Royal Canadian Air Force Base (Lat. 63°45′ N., Long. 68°33′ W.). An 18-square-mile area, most of it high desert tundra, but some of it marshy lowland near the sea, we covered thoroughly. In this study-area, which lay principally just to the north and northeast of the Base, we failed to record a jaeger (*Stercorarius*) of any species, we did not once see the Arctic Tern (*Sterna paradisaea*), and we found only one shorebird breeding at all commonly—the Semipalmated Plover (*Charadrius semipalmatus*). This species preferred well-drained gravelly places for its nesting. One other shorebird bred in the area or somewhere close by—the Red-necked (Northern) Phalarope (*Lobipes lobatus*). We did not find this species' nest, but we collected a male with well-defined brood-patches.

This failure to find jaegers, terns, and nesting shorebirds was not the result of inattention or inactivity. During the season of migration we recorded the White-rumped Sandpiper (*Erolia fuscicollis*), Semipalmated Sandpiper (*Ereunetes pusillus*), and Red Phalarope (*Phalaropus fulicarius*) repeatedly, and we fully expected to find these species breeding; but by the end of June they had left us. For a time we blamed the shorebird shortage on the comings and goings of aircraft, on mosquito-control and drainage measures, etc., but when we visited the undisturbed grassy flats near the mouth of the Jordan River, 16 miles west of the Base, and found very few shorebirds there, we concluded that the whole head of the bay was, for reasons beyond our understanding, unattractive to shorebirds. Near the mouth of the Jordan several Semipalmated Plovers and a few White-rumped Sandpipers and Semipalmated Sandpipers were nesting.

The absence of jaegers we attributed at first to the local abundance of Snowy Owls (*Nyctea scandiaca*). We reasoned that the owls had established themselves early, well before our arrival, and driven the jaegers out. But

as our data accumulated, as it became increasingly apparent that lemmings (both *Dicrostonyx groenlandicus* and *Lemmus trimucronatus*) were common, while such lemming-eaters as foxes (*Alopex lagopus*) and weasels (*Mustela erminea*) were either very rare or missing altogether, we concluded that more than the single factor of lemming-availability was necessary to make the region attractive to jaegers. In this connection we point out that the Rough-legged Hawks (*Buteo lagopus*) of our study-area were living exclusively, and the Peregrines (*Falco peregrinus*) extensively, on lemmings.

What kept Frobisher Bay from being attractive to shorebirds, jaegers and terns became a sharply defined question with our first trip to the southeast shore of Lake Amadjuak (Lat. 64°38′ N., Long. 70°28′ W.) on August 8. Here, less than 100 miles northwest of the head of Frobisher Bay, we found the American Golden Plover (*Pluvialis dominica*), Purple Sandpiper (*Erolia maritima*), Pomarine Jaeger (*Stercorarius pomarinus*), Long-tailed Jaeger (*S. longicaudus*), and Arctic Tern breeding. Again, on August 11, in the vicinity of Cape Dorchester (Lat. 65°20′ N., Long. 77°10′ W.), we found the Parasitic Jaeger (*Stercorarius parasiticus*), Long-tailed Jaeger, Arctic Tern, American Golden Plover, and White-rumped Sandpiper breeding. On our second trip to Lake Amadjuak, August 15, we collected a Red Phalarope which almost certainly had bred there.

Some of the above-mentioned birds seem to require vast stretches of wet grassy tundra for their breeding. Here the comparatively lush vegetation furnishes some shelter when the weather turns rough. Here there is food. Here the great stretches of shallow water provide nest-sites inaccessible to certain predators—low islands of all shapes and sizes, some wet, some dry; long peninsulas; off-shore bars; marshes—areas in which it is possible during the brief but well-lighted period between arrival from the south and establishment of nest-territories to ascertain, through experience hour after hour, which spots are best—i.e., the closest to a good food supply, the most comfortable, and the least molested. Certain mammalian predators are a primary concern for all birds. Foxes prey on owls, jaegers and large gulls, as well as on plovers and "peeps." Factors which make an area attractive to shorebirds may not attract jaegers directly, but the shorebirds themselves do, for jaegers eat shorebirds. Islands are requisite to the successful breeding of some colonial species, such as the Arctic Tern, and in such species an abundance of individuals may be a factor attracting more individuals.

One has to cross this flat, monotonous grass tundra afoot, mile after mile of it, to appreciate its character. Off in every direction, as far as the eye can see, there are ponds. A distant lake, seen through the binocular, looks good for birds, for there is a scattering of little islands along the shore. Reaching this lake requires a circuitous route around and between a score

of lesser ponds, for nowhere is the water shallow enough, or the bottom firm enough, for easy wading. By the time one has reached the lake, visited the nearest of the little islands, and followed a stretch of the shore-line, one realizes how birds nesting at the very tips of the long peninsulas, or off in the middle of the big marshes, escape predators by the sheer circumstance of being where they are.

We have reported on two of the following species, the Semipalmated Plover and Purple Sandpiper, in detail elsewhere, but we refer to them briefly for the sake of completeness.

Charadrius semipalmatus. Semipalmated Plover.—This, "the common plover of Baffin Island" (Soper, 1928:102), nested in the immediate vicinity of the Base, on Davidson Point, about Tarr Inlet, near the mouth of the Jordan River, and here and there in the interior, in gravelly places near rivers. We did not find it at Lat. 68°31′ N., Long. 71°22′ W., near a lake about 50 miles east-northeast of Wordie Bay, August 8; at Lake Amadjuak, August 8 and 15; or at Cape Dorchester, August 11 (see Sutton and Parmelee, 1955*b*:138). The Ringed Plover (*C. hiaticula*), a species reported from more northeasterly parts of Baffin Island (Kumlien, 1879:83; Soper, 1928:103; Shortt and Peters, 1942:343; Wynne-Edwards, 1952:367–369), we did not see.

Pluvialis dominica. American Golden Plover.—We recorded this species at the head of Frobisher Bay only once. On June 22, we collected a male (GMS 11718) in almost complete breeding plumage just north of the Base. The bird was blind in one eye, yet it was fairly fat and its stomach contained insect and spider remains, some tiny seeds, and the flesh of winter-refrigerated crowberries (*Empetrum nigrum*).

At Lake Amadjuak, on August 8, we saw two adults and heard others in the distance. The plateau-like breeding area was well back from the lake-shore. An adult male collected (GMS 11820) was in mixed plumage. It must have had young near by, for it flew toward us boldly then ran off with head low, tail spread, and wings drooping.

Near Cape Dorchester, on August 11, we heard the Golden Plover repeatedly; were followed about by a clamorous adult which must have had young near by; noted a flock of eight, high in air, and a single adult, not so high, flying swiftly southeastward; and observed two strong-flying young birds, siblings probably.

At Lake Amadjuak, August 15, we saw about 20 Golden Plovers, four of them sibling chicks barely able to fly. One of these (male, GMS 11840) we collected. It was downy on the forehead, supercilium, chin, throat, mid-chest, tibial region and under tail coverts. The incoming plumage of the fore-neck, chest, belly and sides was much spotted. The first-winter crown feathers, back feathers, scapulars, rump feathers, and upper tail coverts were spotted with rich yellow. Several parent birds followed us noisily in the high country back from the lake-shore. In one area the eight birds formed a sort of flock. They flew up together, circled us in a group, and alighted together. They were blotched or spotted rather than solid black on the under parts, and not one of them was boldly white on the sides of the neck. The alarm cry was not the familiar *too-lee-oo* or *too-di-lee*, but a more elaborate *kill-ee-oh kill-ee*, or *pull-ee-oo plee-ee*. This fact we had opportunity to check repeatedly. We collected one adult, a molting male (GMS 11848). Its under parts were lightly blotched with black.

Soper (1946:226) noted this species "frequently" at Cape Dorchester in late August, 1928. Neither Kumlien (1879) nor Wynne-Edwards (1952) listed it, and our Frobisher Bay record apparently is the first for that area. We did not see the species in the Wordie Bay district, August 8.

FIG. 1. Muddy tundra of the Purple Sandpiper breeding ground. Photographed August 15, 1953, near the southeast corner of Lake Amadjuak, Baffin Island.

Measurements, in millimeters, of our three adult males (GMS Nos. 11718, 11820, 11848) are: wing, 178, 173, 179; tail, 67, 65, 69; exposed culmen, 23.5, 23.5, 23.0; tarsus, 40.0, 42.0, 42.0. The specimens represent the nominate race.

Squatarola squatarola. Black-bellied Plover.—This species we recorded three times on the tidal flats near headquarters: on June 16, three seen in an area strewn with large boulders and seaweed; on June 19, one heard in the distance; and on June 20, one heard and another seen. Near Cape Dorchester, August 11, we heard the mellow *too-ree* in the distance several times but did not collect a specimen.

Soper (1946:227) found this species one of the "most characteristic birds" of the Bowman Bay area, June 6–18, 1929. After June 18 "the majority passed on to north, but fair numbers remained to breed on the lowlands . . ." Our Frobisher Bay records apparently are the first for that area.

Arenaria interpres. Ruddy Turnstone.—We saw two turnstones on the tidal flats near the Base, June 16. Though brightly colored, they were not in complete breeding feather. Taking alarm at our approach, they flew to some big rocks above high-tide mark where they were joined by three White-rumped Sandpipers. On June 27 we saw a single turnstone feeding in a sheltered cove along the shore of Davidson Point.

On August 11 we heard the rattling cry of a turnstone along the shore of the lake in which our amphibious aircraft alighted not far from Cape Dorchester.

Erolia maritima. Purple Sandpiper.—We collected several Purple Sandpipers on rocky islands near the head of Frobisher Bay July 29 to August 6, but the species did not breed near the Base or at the mouth of the Jordan River. Along the southeast shore of Lake Amadjuak (Fig. 1) we found a sparse breeding population, August 8 and 15. Here we took adult and young specimens, the latter barely able to fly (Sutton and Parmelee, 1955*a*:218). We did not record the species in the Wordie Bay district or at Cape Dorchester.

Erolia fuscicollis. White-rumped Sandpiper.—This species Soper (1946:229) found breeding about Nettilling Lake and Bowman Bay. Concerning its abundance at the latter locality in spring he says: "Like the Purple Sandpipers, they invaded the region in

almost incredible numbers and swarmed over every available patch of tundra, only lately cleared of snow. This intense wave of migration persisted from June 8 to 14, after which their numbers gradually diminished, but a large . . . population remained to nest on the surrounding tundra."

We saw very little of the species anywhere about Frobisher Bay. In the vicinity of the Base we recorded it a few times June 15 to 21, but witnessed neither courtship nor flight-singing. On June 15 we saw five birds—two together by themselves and three with two Semipalmated Sandpipers. The White-rumps worked their way daintily through the grass, sometimes wading deep in water which spilled swiftly from a pond close by. June 16 we saw ten White-rumps, three "singles," two "pairs," and a group of three which joined two turnstones on a rock above high-tide mark. On June 18 we saw a few White-rumps on Davidson Point, one of them with some Red Phalaropes, and found White-rump remains below a Peregrine eyrie near the mouth of the Sylvia Grinnell. On June 21 we saw a single White-rump on the tidal flats not far from the Base.

On July 18, just west of the mouth of the Jordan River, we found a female White-rumped Sandpiper and her brood. The old bird's principal callnote was the well-known *chick* or *tsick*, which she uttered only in flight; but she also twittered or chattered as she circled us. Three of her brood, two males and a female, unable to fly and still quite downy, we caught one by one, with a series of prolonged waits and headlong dashes across the tundra. They ran with astonishing speed. One which disappeared while we were watching it through our glasses we found in a lemming burrow. Held in the hand, it struggled and cheeped. We heard no call from any of the chicks while they were running free. The adult's bill (GMS 11765) was rich orange-brown at the base, grayish black otherwise. The tarsi and toes were dark brownish-gray. In each of the young birds (GMS 11766,-7,-8) the bill was dark gray with olive base, the tarsi and toes gray with olive tinge. The area inhabited by these birds was decidedly wet—the marshy edges of a small, shallow pond. We failed to find the male parent.

On July 19 we found another adult White-rumped Sandpiper in about the same marshy area. It was not very demonstrative, but lingered in the vicinity. It proved to be a female (GMS 11772) with distinct brood-patches.

The grassy area in which we found these birds extended for two or three miles along the bay-shore and two miles or so up the Jordan. A few Semipalmated Sandpipers bred in slightly drier parts of the same area. The Semipalmated Plover was restricted to well-drained gravelly places not far from the river.

August 15 we saw a single White-rumped Sandpiper on the tundra well back from the shore at Lake Amadjuak. We did not record the species at the head of Frobisher Bay in August.

Measurements of our two adult females (GMS 11765, 11772) are: wing, 122, 120; tail, 53, 52.5; exposed culmen, 23.0, 22.0; tarsus, 24.5, 24.0.

Erolia bairdi. Baird's Sandpiper.—This species is said by Soper (1946:230) to be "much less common" than the White-rumped Sandpiper in southern Baffin Island. We noted it three times: June 15, in a grassy spot near the Base, three birds together not far from three White-rumped Sandpipers and two Semipalmated Sandpipers; June 16, three birds, together on the tidal flats near the Base; and June 18, three birds together along the sandy shore of a large shallow pond near the landing-strip. On each occasion the birds gave rolling cries on flying up. We did not observe courtship or flight-singing.

We looked in vain for the species in the Wordie Bay district, along the southeast shore of Lake Amadjuak, and at Cape Dorchester. Wynne-Edwards (1952:369) found the bird "common" at Clyde, on the coast and at the head of Clyde Inlet.

Ereunetes pusillus. Semipalmated Sandpiper.—This species we recorded several times in the vicinity of the Base: June 15, two feeding not far from three White-rumped Sandpipers and three Baird's Sandpipers; June 16, seven or eight birds in all, one of them trilling briefly from a standing position; June 17, two birds together in grassy tundra; June 18, three or four birds about pools on Davidson Point; June 20, one bird, feeding near the outlet of a tundra pond, another, trilling loudly both on the ground and in flight, on Davidson Point. This last bird we collected, finding it to be a male (GMS 11716). Each testis measured about 6×4 mm.

On grassy flats just west of the mouth of the Jordan River we found several Semipalmated Sandpipers on July 18. Well back from the high-tide mark we ran down a still partly downy chick (female, GMS 11768) and shot the parent, a male (GMS 11769), whose alarm cry was a musical *tsert* or *chert*. Much closer to the salt water, at the edge of the grassless flats, we caught a very small male chick (GMS 11770), probably only a day or so old. Here we saw several adults, probably both males and females. On July 19, in this same general area, we counted about 20 adults, all of which seemed to be agitated. Some distance inland we collected a single male (GMS 11773) not far from a little pond. It had well defined brood-patches but very small testes.

On August 15 we saw about twenty scattered Semipalmated Sandpipers in a flat stretch of tundra about 200 yards from the southeast shore of Lake Amadjuak. We collected one young bird, a partly downy male (GMS 11844). The adults had a way of standing quietly, then flying up suddenly in groups of three or four. One of them gave a bit of a trill.

We last saw the species on August 18—a single bird among several Semipalmated Plovers on the tidal flats not far from the Hudson's Bay Company Post.

Our three adult male specimens (GMS 11716, 11769, 11773) measure: wing, 90, 93, 94; tail, 42.5, 43.5, 42.5; exposed culmen, 20.0, 19.5, 20.0; tarsus, 20.5, 21.0, 21.0.

Phalaropus fulicarius. Red Phalarope.—We saw so much of this species near the Base June 15–20 that we thought surely it would remain to nest, but it did not. On June 15 we saw about 20 males and about 26 females in two and threes on little ponds just north of the Base. Several times we saw two males and a female together twirling about or dabbling for food. Callnotes were a reedy *pheep*, an incisive *fick* or *fitick*, and a *chu-eep*. June 16 we saw large flocks in salt water pools between the bay-ice and the shore, smaller flocks in tidal pools, and scattered groups on the tundra ponds. June 17 we saw good-sized flocks of both males and females in partly thawed lakes and the larger tidal pools and heard sounds of wing-fluttering from courting females. June 18 we saw a good-sized flock flying about the pools on the tidal flats, but on the tundra ponds the birds were in scattered twos and threes. On this date we found Red Phalarope remains below a Peregrine eyrie near the mouth of the Sylvia Grinnell and in the stomach of a male Peregrine collected.

By June 19 the height of the shorebird migration had passed. On that date we saw six Red Phalaropes, three of which (two males and a female) we collected. Each of the four testes measured about 10×6 mm. On June 20, the last date on which we recorded the species about Frobisher Bay, we saw three females and two males in a pond on Davidson Point.

In a marshy area between two ponds near Lake Amadjuak, August 15, we collected a molting male which fluttered about calling anxiously as if in concern over a brood. There was a large brood-patch at either side of the belly and feathers dropped out badly during skinning.

We did not see the species in the Wordie Bay district, August 8, or near Cape

Dorchester, August 11. Measurements of our three male specimens (GMS 11711, 11645, DFP 51) are: wing, 122, 126, 124; tail, 61, 61, 60; exposed culmen, 21.5, 23.0, 22; tarsus, 20.5, 21.0, 21.5; of the female (GMS 11712): wing, 126; tail, 62; exposed culmen, 21.5; tarsus, 21.0.

Lobipes lobatus. Red-necked Phalarope.—This species we found only on Davidson Point, just west of the Base; on July 1 we flushed a single individual from the grassy edge of a pond near the dump. It fluttered up, hesitated as if about to return to the water, then shot off erratically, calling *pit! pit!*

The following day we failed to find the bird at this pond, but took the general direction it had taken, and presently flushed a Red-necked Phalarope. We followed it, ascertaining that it was a male. While we were stalking it, a female appeared and the male fluttered its wings without leaving the water. The female flew off and we did not see her again. We collected the male, finding large brood-patches among the belly plumage. We searched a long time for a nest, but in vain.

These birds were in the marshiest, grassiest part of Davidson Point. In the middle of the pond from which we first flushed the male on July 2, the water was about a foot deep and the bottom muddy. There was no comparably marshy area anywhere just north of the Base or near the mouth of the Jordan River, but marshes near Cape Dorchester and at Lake Amadjuak were of similar character.

Wynne-Edwards (1952:370) reports "unidentified phalaropes" from several localities, including Frobisher Bay (September 13, 1950). Despite Kumlien's considerable discussion (1879:84) of the nesting of this species in Cumberland Sound, Taverner (1934: 526) says that it is known to breed "northward only to Southampton Island, northern Labrador, and the northwestern mainland." Soper (1946:232) mentions a male bird seen in the Bowman Bay area June 26–27, 1929. Bray and Manning (1943:526) collected a male and two females in the Taverner Bay area in 1939 and 1940. Shortt and Peters (1942:344) believed that six phalaropes which they saw at sea near Lake Harbour on August 14, 1939 were of this species.

Stercorarius pomarinus. Pomarine Jaeger.—We saw the Pomarine Jaeger only at Lake Amadjuak. At least two pairs bred near the southeast shore. Long-tailed Jaegers inhabited the same general area in August and we believe the two species had nested not far apart.

We first saw the Pomarine on August 8. That day a pair were flying about near our aircraft's anchorage. We soon discovered that the birds' activities centered about an arm of water in which a young bird, good-sized but apparently unable to fly, was swimming deep with head low. The old birds circled us, sometimes flying close, but they were not at all aggressive (see Pitelka, *et al.*, 1955:6). They tried no distraction behavior. Arctic Terns dived at them occasionally. The jaegers' callnote was a rough *heck* or *keck*. We collected them easily, finding the male (GMS 11821) to be immaculate on the chin, throat, breast and belly, except for a faint dusky band across the chest, while the female (GMS 11822) had a broad dark chest-band and much dusky flecking in the middle of the throat and throughout the whole belly. The female was the larger, but not conspicuously so. Her long middle rectrices, unlike those of the male, were almost perfectly flat. They protruded beyond the rest of the tail 71 mm., while those of the male protruded 75 mm. In both specimens the tarsi and toes (including the webs) were dull black, the bill brownish olive as far forward as the anterior edge of the nostrils, dusky on the tip. The testes measured about 6×4 mm. On the belly of the female, *but not of the male*, were two large brood-patches. Pitelka, *et al.* (1955:5) report brood-patches in specimens of both sexes.

The young bird (male, GMS 11823) was shaggy with brownish gray down, especially on the head and under parts. The tarsi and proximal parts of the toes (and their webs) were pale blue, with faint green tinge, the distal parts of the toes (and webs) dusky. The bill was dull bluish gray, the eyes dark brown.

On August 15, not far from the area in which we had collected the three above-discussed specimens, we saw at least three adult Pomarine Jaegers (one white below; one dark below; one white below except for a dark chest-band) and a young bird. We did not see two adults together, and when, apparently by sheer chance, we came upon the young bird, no parent bird attacked us. The chick was nowhere near a lake or marsh. It could fly a very little, but we had no trouble catching it. Though downy all over the head and under parts, it was perceptibly more mature than the chick collected August 8. Its tarsi were pale blue, fading gradually to pinkish flesh-color on the proximal third of the toes and their webs, then changing abruptly to dusky. It was very restless. We wanted to photograph it but it would not keep still. While we were handling it a parent bird called in the distance and it gave a weak-voiced reply.

The above-discussed breeding records may well be the first for Baffin Island. Kumlien (1879:94) reported the species' nesting along the west side of Davis Strait, but, as Salomonsen (1950:261) points out, the Pomarine Jaeger "certainly does not nest on high cliffs," and Kumlien's statements seem to us to describe jaegers at the nesting-cliffs of other seabirds upon which they possibly were preying. Soper, in his earlier report (1928:80), mentioned no breeding records aside from those of Kumlien; more recently (1946:232-3) he has called the Pomarine Jaeger "a comparatively rare bird" in the Bowman Bay area, and has stated that in southeastern Baffin Island its breeding is "uncertain."

We did not record the species anywhere about Frobisher Bay, in the Wordie Bay district, or in the vicinity of Cape Dorchester. Wynne-Edwards (1952:370) tells us that Anderson recorded it in Frobisher Bay September 15–16, 1950.

Stercorarius parasiticus. Parasitic Jaeger.—This species we saw only near Cape Dorchester, where we collected an adult male (GMS 11830) August 11. It was one of a pair to which we were attracted by hearing the loud *error, error* callnotes in the far distance. The specimen is creamy white on the chin, upper throat, breast and belly, but light brownish gray across the lower throat. The bill was black at the tip, olive throughout the dertrum, and purplish flesh-color on the basal half of the lower mandible. The tarsi and toes were blackish gray. In the stomach were Lapland Longspur feathers.

Stercorarius longicaudus. Long-tailed Jaeger.—This jaeger we did not record in the Wordie Bay district or in Frobisher Bay. We first saw it on August 8, at Lake Amadjuak, a single bird flying in the distance. On August 11 we found a family near Cape Dorchester. The two young, which were very dark and almost completely free of down, flew well. They amazed us by coming straight for us, diving at us in the manner of adults defending a nest. Their cry was a shrill *kree-a*, sometimes repeated rapidly. They were much bolder than their parents. They chased each other playfully, calling noisily, never getting very far apart, and alighting within a few inches of each other. We collected all four birds (GMS 11831, -2, -3, -4). One chick was a male, the other a female. The tarsi of the young were bluish gray, the toes (with webs) dusky. In the stomachs of the adults and of one of the chicks were lemming remains. In the stomach of the other chick was the humerus of a small passerine bird. Both chicks were very fat. The wing-spread of the young male was 31 inches.

At Lake Amadjuak, on August 15, we saw several Long-tailed Jaegers near marshy ponds about two miles from the comparatively dry upland in which we found the young

Pomarine Jaeger that same day. On a ridge between ponds we saw two parent Long-tailed Jaegers and their single progeny, a dark bird which flew well but giddily. The parent birds had a way of swinging upward into the wind and hanging in one spot with wings beating. The callnote of these three birds was a ringing *kree-kree* or *kree-pee*. The ridge was alive with Rock Ptarmigan (*Lagopus mutus*) to which the jaegers paid no attention so far as we could see.

Larus hyperboreus. Glaucous Gull.—This species we saw almost daily, usually near salt water, but occasionally well inland along a stream. We often saw it along the Sylvia Grinnell, invariably flying above water. Two birds which scolded us loudly three miles upriver from the mouth on June 19, probably had a nest on a low cliff there. On June 24, at a Snowy Owl nest near a small river east of the Base, a Glaucous Gull joined the owls in scolding and swooping at us. On this occasion the gull left the river entirely.

On rocky islands off the mouth of the Jordan River several pairs of Glaucous Gulls nested. We saw about 70 individuals (all adult) on our first visit to this area, July 13, but many apparently without nests or young. Above an island on which Common Eiders (*Somateria mollissima*) were nesting a pair of scolding gulls circled. We found a new-looking nest of this gull and part of a gull's egg, but no chicks. Near another island we collected an adult male Glaucous Gull (GMS 11755). It had three well-defined brood-patches into which new feathers were growing. The beak was yellow with a subterminal spot of orange on the mandible, the eyelids deep yellow, the irides light yellow, the tarsi and toes (including webs) pinkish flesh-color. In each wing five outer primaries were unmolted.

On July 17 we found three pairs of Glaucous Gulls nesting along the gorgelike channel between Hill and Bishop Islands. Their scolding note was a deep *ka, ka, ka*. Occasionally they squealed or yelped. They dived at us cautiously, never coming very close. That all were molting was evident from a notch in the following edge of each wing. Herring Gulls were nesting about lakes in the interior of Hill Island. Between the clifflike outer shore and these lakes we were scolded by both Glaucous Gulls and Herring Gulls and dived at fiercely by the latter. The same sort of overlap existed just west of the Jordan River mouth, July 18–19. In these zones of overlap a Herring Gull often gave chase to, or dived at, a Glaucous Gull, but not *vice versa*.

On July 27 we examined two well-grown young Glaucous Gulls which Eskimos had caught a week or so earlier. This taking of good-sized chicks, late in the season, may explain the non-breeding status of many of the adult gulls we saw near the mouth of the Jordan River.

On July 29, on a high rocky island across the bay from the Base, we found several Glaucous Gulls nesting. In an adult female specimen (GMS 11796) collected that day four outer primaries in each wing were unmolted.

We did not see the Glaucous Gull at Lat. 68°31′ N., Long. 71°22′ W., at a large lake 50 miles east-northeast of Wordie Bay, August 8, or along the southeast shore of Lake Amadjuak, August 8 and 15. We saw a single Glaucous Gull near Cape Dorchester, August 11.

The male and female specimens mentioned above (GMS 11755 and 11796) measure: wing, 465, 434; tail, 196, 186; exposed culmen, 61, 59; tarsus, 67, 68. The bill of the male, though only slightly longer than that of the female, is noticeably heavier.

Larus kumlieni. Kumlien's Gull.—This species we did not identify with certainty. A gull with pure white tail and with what appeared to be gray rather than black

wingtips circled over us while we were on the tidal flats near the Base, June 16. A loose flock of 17 gulls, feeding on the Tarr Inlet tidal flats, June 25, seemed to be small for Glaucous Gulls, but no bird among them could we identify positively, so we could not be sure how large they were. Their wingtips were not conspicuously black. A compact flock of about 100 gulls at rest along the edge of Tarr Inlet at low tide on July 7 also appeared to be smaller than Glaucous Gulls. Many of these must have been subadult. Flying birds which appeared to have perfectly white tails did not have clearly black wingtips. Some of the youngest-looking birds were quite dark all over and cold gray, rather than brownish gray or buffy, in tone. None of these seemed to be conspicuously dark above and white below, like the young gulls seen by A. Anderson in Frobisher Bay, September 13 to 15, 1950 (Wynne-Edwards, 1952:371).

An immature gull with slight limp, feeding at low tide among seaweed near Davidson Point, June 30, had very dark remiges. The contrast between the "blackness" of these feathers and the lightness of the wing coverts was noticeable when the wings were spread. Note, in this connection, that Kumlien (1879:99) described the "primaries and tail" of full-grown young *Larus glaucescens* (=*Larus kumlieni*) taken in Cumberland Sound in early September as "*very nearly black.*"

Larus argentatus. Herring Gull.—This gull we saw repeatedly, usually inland rather than along the coast. It nested in scattered pairs or small groups on islands in large lakes.

The non-breeding gulls which we saw from time to time (July 7–22) in Tarr Inlet we have already discussed. Where these birds went at high tide we did not learn. We could not get near them, and we had difficulty seeing them clearly even with binoculars. They kept together, feeding near the tidal streams or resting in a compact group. On July 7, there was a marked difference between their wariness and the boldness of a single Herring Gull which circled us, scolding, and finally began diving at us. We collected this bird (GMS 11744), finding it to be a male with three well defined brood-patches, molting primaries, and small testes.

On July 17, near deep-looking lakes in the interior of Hill Island and about 300 feet above sea-level, we came upon three pairs of Herring Gulls, all of which dived at us. On scanning the largest lake with our binoculars, we descried five young gulls, two on an island and three in the water just beyond. These chicks, though good-sized, were still somewhat downy.

Between the mouth of the Jordan and the high country a mile or so to the west, were rough, lake-dotted hills. Here several Herring Gulls nested. So long as we stayed along the river the only gulls which scolded us were Glaucous Gulls; but if we moved westward into the tundra the Herring Gulls came to meet us. Dividing their attention between us and the Glaucous Gulls, they scolded loudly and dived with vigor.

On August 3, we saw four pairs of Herring Gulls flying about over lowland meadows just east of Tarr Inlet. In each of two lakes was an islet on which there was a gull nest. Not far from one of the nests was an apparently full-winged young bird, swimming high in the water. It was of a light buffy color, in this respect being quite different from "average" young *argentatus* Sutton had seen on the Labrador and on Southampton Island.

On August 11, we saw several adult Herring Gulls near Cape Dorchester. They dived at us repeatedly, so probably had young in the lakes. On August 15, we collected an adult female Herring Gull (GMS 11846) along the southeast shore of Lake Amadjuak. It was one of the four adult Herring Gulls we saw there that day.

Our male and female specimens (GMS 11744 and 11846) measure: wing, 420, 407;

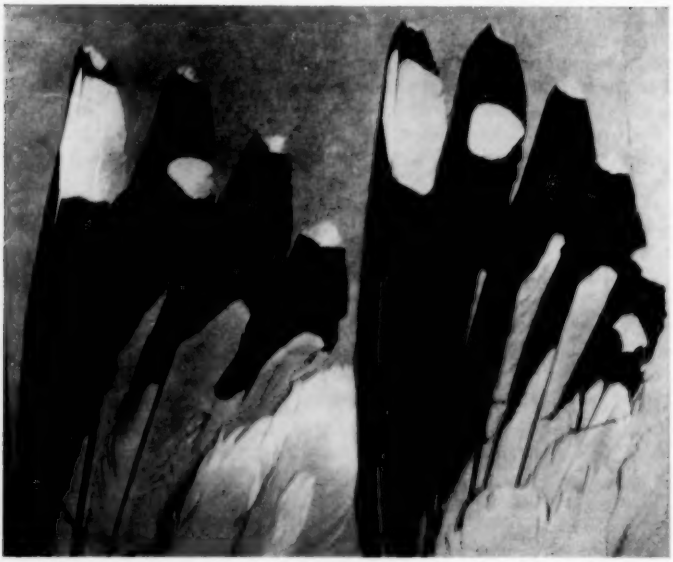

FIG. 2. Wing-tips of breeding adult *Larus argentatus smithsonianus* from southern Baffin Island. *Left:* male, GMS 11754, Tarr Inlet, near head of Frobisher Bay, July 7, 1953. *Right:* female, GMS 11846, Lake Amadjuak, August 15, 1953.

tail, 178, 169; exposed culmen, 55, 51; tarsus, 60, 61. These represent the race *smithsonianus*, apparently. Whether *L. a. thayeri* is actually "a little smaller" than *smithsonianus* (see Dwight, 1917:414) or not, the wing-tip pattern of *thayeri* is distinctive. A comparison of Figure 2 with the wing-tip patterns of *smithsonianus* and *thayeri* as illustrated by Dwight (1917:413; 1925:353, Fig. 101, and 354, Fig. 103) reveals that, at least as regards this character, our birds are not even close to *thayeri*. Wynne-Edwards (1952:371) has reported *smithsonianus* from Frobisher Bay, but from the wording of his statement we are not sure that this subspecific determination was based on specimens collected or examined by him. Soper (1946:236) makes this statement: "All birds examined from southern Baffin Island are unmistakable *smithsonianus*."

Xema sabinei. Sabine's Gull.—Taverner (1934:125) calls "southwestern Baffin Island" the eastern limit of this species' breeding in the Arctic Archipelago. Soper (1946:237) says that the bird "breeds abundantly" about Bowman Bay, but that it is rare and irregular in eastern Baffin Island. Shortt and Peters (1942:345) report a September sight record for Clyde Inlet and a July specimen taken on Big Island (not far from Lake Harbour). We recorded it only once: seven adults in breeding feather on the tidal flats near the Base, June 16. After flying over the open water between the shore and the bay-ice and feeding about the numerous tidal pools, they settled on a mud bar. We collected three males and a female, all very fat, and all somewhat rosy on the breast and belly. They had dark brown eyes and vermilion eyelids and mouth-lining. The bill was black throughout the basal two-thirds, dull yellow at the tip. The legs

and feet were grayish black except for the slightly paler distal third of the front of the tarsus. The gonads were considerably enlarged. The stomachs were well filled with small crustaceans, hundreds of which we had seen alive on the flats. These "shrimps" were somewhat curled up when dead; when straightened out and swimming they looked like tiny minnows.

Sterna paradisaea. Arctic Tern.—If this species breeds at all in southeastern Baffin Island it must do so irregularly. Taverner (1934:126) says that records "along the west shores of Davis Strait and Baffin Bay are few." Kumlien (1879:101) saw "thousands" on June 19 and 20 in Cumberland Sound, but this was his only record for that area. Dalgety (1936:587) found terns "fairly numerous on the rivers and lakes" about Eglinton Fjord August 14–29, 1934, but Wynne-Edwards (1952:372) did not even see the bird in that district August 20–27, 1950. Soper (1946:238) says that the Eskimos at Lake Harbour are familiar with the bird, that they observe it "sometimes commonly," especially in autumn, but that they "appear to know of no nesting places."

We did not see the species anywhere about Frobisher Bay in 1953. We did find it, however, at Lake Amadjuak and near Cape Dorchester. At Lake Amadjuak we saw at least seven adults on August 8. They flew up rapidly while we were trying to capture a young Pomarine Jaeger. They dived at us a few times but soon gave their undivided attention to the parent jaegers, which did not return the attack. On August 15 we saw five adult terns at Lake Amadjuak. One of these, a male (GMS 11847), we collected. It was not molting.

Near Cape Dorchester, on August 11, we saw several small parties of adult terns, but found no well-defined colony. As we were walking along the shore of a large lake, four scolding terns flew toward us, high in air. A Herring Gull also flew up, and the terns attacked it fiercely, pecking so hard that it made off squawking. Near a low island, well out from shore, we finally descried two tern chicks, fairly well grown but still downy. At lakes near by we collected two adult male terns (GMS 11835, –6). They were in full breeding plumage, i.e., not molting. The testes each measured about 7×5 mm. The stomach of one bird held a mass of partly digested small fish.

Uria lomvia. Brünnich's Murre.—Wynne-Edwards (1952:372) saw many Brünnich's Murres along the north side of Frobisher Bay, "especially . . . off the southeast coast of Lok's Land," on August 8, 1937. Soper (1946:238) mentions Eskimo reports of colonies "on the cliffs of Resolution Island and . . . the sheer rocky promontories of the opposite coast along Gabriel Strait." We recorded the species only once: a solitary adult male (GMS 11795) collected July 29 in the middle of the bay several miles south of the Base. It was in breeding plumage, not molting, and fat, but not excessively so. There was no brood-patch. The right testis measured about 4×25 mm., the left, 4×17. The mouth-lining was yellow. The feet were grayish black except for the dull brownish yellow of the front and sides of the tarsi and tops of the toes. The specimen represents the nominate race, the wing measuring 201 mm. (primaries pressed flat), the culmen, 33.

Cepphus grylle. Black Guillemot.—This species breeds in Frobisher Bay, but we found neither nests nor young. On June 24, an Eskimo reported seeing an adult at high tide between the bay-ice and the shore. On June 27, we saw about 20 near a mass of broken-up ice off the mouth of the Sylvia Grinnell River. On July 13, on our 35-mile boat trip to the Jordan River and back, we saw only two birds. They were flying along the edge of a mass of ice well out in the bay.

On July 17, we saw two guillemots along the outer shore of Hill Island and two

more in the channel between Hill and Bishop Islands. The birds may well have been nesting in the rubble at the foot of the shoreline cliffs. On July 20, between the Base and the mouth of the Jordan, and late at night, two guillemots flew round our boat and alighted. We shot one (GMS 11776). An hour later, near Davidson Point, two more flew up, circled, and alighted, and again we shot one (GMS 11777). Both of these proved to be fat males with small testes. Neither had a brood-patch and neither had anything in its stomach.

On August 6 we saw several adults among islands about five miles southeast of Tarr Inlet. The only specimen collected, a male (GMS 11818), was not fat. A well-defined brood-patch, without any sign of median feather partition, extended across the belly. The stomach was empty.

Measurements of the three above-mentioned males (GMS nos. 11776, 11777, 11818) are as follows: wing (primaries pressed flat), 156, 155, 165; culmen, 31.5, 30, 31.

Whether these three birds were actually breeding is a question. The last was obviously the only full adult of the three. It was the only one having a brood-patch and the only one in which the flight feathers (both wings and tail) showed neither fading nor wear at the tips. Its black plumage throughout is exceedingly rich, glossy, and fresh looking. The white feathers of the wing-patch are without dark tipping of any sort, though the distal greater secondary coverts are dark basally along the shaft proper. The basal white area of the outer primary's inner web extends to within 49 mm. of the tip.

In no. 11776, virtually every feather of the white wing-patch is tipped with brown, most of the secondaries have a small white spot at the tip, and the basal white of the outer primary's inner web extends to within 35 mm. of the tip. In no. 11777, the secondaries and greater and middle primary coverts are boldly tipped with white, a very few feathers of the white wing-patch are tipped with brown, and the white of the outer primary's inner web extends to within 24 mm. of the tip. The wing is much like that of the "extreme" *mandti* figured by Wynne-Edwards (1952:373), though we find no statement as to the amount of white on the inner web of that bird's outer primary.

We wonder if birds in this plumage actually breed. We wonder, too, what advantage there is in recognizing this "hybrid swarm" (Wynne-Edwards, *loc. cit.*) or "heterozygotous assemblage" (Salomonsen, 1944:91) as a geographical race. Two of the specimens discussed above must be very close indeed to true *mandti*, for they have little or no black at the base of the greater secondary coverts, yet the three specimens vary greatly as regards the amount of white on the inner web of the outer primary. Gross (1937:37) reports both *mandti* and "*arcticus*" in certain Button Islands breeding populations.

Acknowledgments

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Department of Zoology, University of Oklahoma, Norman, Oklahoma, September 12, 1955

DESTRUCTION OF WARBLERS ON PADRE ISLAND, TEXAS, IN MAY, 1951

BY PAULINE JAMES

In May, 1951, I had an opportunity to investigate an incident of mass destruction of migrating warblers on Padre Island on the Gulf Coast of Texas.

Padre Island, extending from Corpus Christi on the north to Port Isabel, 125 miles to the south, is one of a series of sand bars that parallels the Gulf Coast of Texas. In June, 1950, a causeway connecting Padre Island with the mainland at a point about 15 miles south of Corpus Christi was opened. The Nueces County Park was established at the north end of the island on the Gulf side. It is located on the open beach with blowing sand dunes about 100 yards inland except for a level area at the entrance to the park from the causeway. Vegetation is very sparse in the park. About two miles to the north there is some scrubby underbrush, chiefly *Quercus*. In connection with recreation facilities, ten large floodlights on high poles are spaced through the park area for use in night fishing. It was in this recreation area in the immediate vicinity of the lights, which are controlled by photo-electric devices on the mainland at Corpus Christi, that thousands of song-birds were killed on May 7, 1951.

On May 6, 1951, South Texas in general experienced unusual weather conditions. Twelve inches of rain fell at Matagorda, and eight inches of rainfall in two hours was reported at Palacios. Widespread rains were reported and small craft warnings were displayed from Brownsville to Louisiana. The cold front that brought the rains moved out into the Gulf late that day (May 6) and was followed by unseasonably low temperatures and 25 m.p.h. winds. On May 7, 1951, local showers and cold northeasterly winds were reported, changing to southeasterly by May 8.

About 8:00 p.m. on May 7, large numbers of songbirds were reported flying into street lights and buildings in Rockport, on the coast about 30 miles northeast of Corpus Christi. At approximately the same time at the Padre Island causeway office, the manager noticed several small birds flying about and around the lights. In Corpus Christi thousands of birds filled the air around lights at a baseball park. At the Corpus Christi Naval Air Station, about five or six miles north of the Nueces County Park, so many birds were said to have flown against the buildings that they piled up to a depth of more than 12 inches. (Restrictions in effect there made it impossible to verify that report.)

About 10:00 p.m. one of the deputies on duty in the recreation area of the park on Padre Island noticed flocks of small birds flying in from over

the Gulf. For the next three or four hours the park was the site of destruction for thousands of exhausted migrants as they flew into a northerly wind and cold drizzle toward the bright lights. Park officials were baffled as to what was happening, but they were concerned about the deaths of the many small birds which flew against the wires and lights. The men who were on duty gathered up as many of the live but exhausted birds as they could and put them into a building in the park to try to save them. However, thousands flew into obstructions and piled up around the light poles. Examination of the dead birds revealed that the necks of a large number of them were "burned" and broken and many showed broken beaks and crushed skulls as a result of their having flown into the wires around the lights.

On May 8, 1951, the early morning newscast carried a report of a "warbler invasion" on Padre Island and the Corpus Christi *Caller-Times* printed a note about the "wild canaries" that had invaded Padre Island during the night. As a result, a large number of Corpus Christi residents got out their bird cages and rushed over to get a free canary; others went out of interest and curiosity. The toll office of the causeway reported the largest number of week-day visitors since its opening.

On May 8, Dr. Ira N. Gabrielson, of the Wildlife Management Institute, and Mr. Luther Goldman, of the U.S. Fish and Wildlife Service, were in the coastal area of the Laguna Atascosa Refuge, approximately 125 miles to the south, and reported large numbers of warblers in the grass and shrubs, apparently resting. They did not see any dead birds there.

At Kingsville we heard the brief radio report and saw the note in the newspaper but could observe nothing unusual in the local bird life. That afternoon, two of my students and I drove the 60 miles to the Nueces County Park to check the reports and to see if we might find some specimens in suitable condition for making into study skins for class use.

Enroute we saw nothing unusual either as to species or as to abundance of birds. It was not until we crossed the causeway that we saw a few dead birds along the road under the light wires. When we entered the recreation area (about three miles beyond the causeway) about 4:00 p.m. we found dozens of birds scattered over the pavement and along the blowing sands. Literally hundreds of Magnolia Warblers in perfect plumage, brilliant Blackburnians, and Bay-breasted and Chestnut-sided and even Blue-winged and Cerulean warblers were scattered over the sands on every side of us. We stopped to examine a few of the specimens that seemed to be in fair condition and then moved on to try to determine the extent of the destruction. Although the dead birds, chiefly warblers, were scattered throughout the entire area, heaviest concentrations were in the immediate vicinity of the light poles. We counted the number of birds under one pole and found more than 900

TABLE 1

SPECIES REPRESENTATION AMONG BIRDS DESTROYED ON MAY 7, 1951, AT PADRE ISLAND, TEXAS

Species	Number of Individuals	Per cent of total
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	1	0.04
Nighthawk (*Chordeiles minor*)	1	0.04
Acadian Flycatcher (*Empidonax virescens*)	16	0.66
Traill's Flycatcher (*Empidonax traillii*)	9	0.37
Wood Pewees (*Contopus virens and C. richardsonii*)	23	0.95
Catbird (*Dumetella carolinensis*)	6	0.25
Olive-backed Thrush (*Hylocichla ustulata*)	1	0.04
Gray-cheeked Thrush (*Hylocichla minima*)	3	0.12
Veery (*Hylocichla fuscescens*)	1	0.04
Cedar Waxwing (*Bombycilla cedrorum*)	1	0.04
Red-eyed Vireo (*Vireo olivaceus*)	1	0.04
Philadelphia Vireo (*Vireo philadelphicus*)	15	0.62
Black-and-white Warbler (*Mnotilta varia*)	46	1.90
Golden-winged Warbler (*Vermivora chrysoptera*)	4	0.17
Blue-winged Warbler (*Vermivora pinus*)	1	0.04
Tennessee Warbler (*Vermivora peregrina*)	16	0.66
Parula Warbler (*Parula americana*)	1	0.04
Yellow Warbler (*Dendroica petechia*)	4	0.17
Magnolia Warbler (*Dendroica magnolia*)	1109	45.81
Black-throated Green Warbler (*Dendroica virens*)	42	1.74
Cerulean Warbler (*Dendroica cerulea*)	6	0.25
Blackburnian Warbler (*Dendroica fusca*)	64	2.64
Chestnut-sided Warbler (*Dendroica pensylvanica*)	165	6.82
Bay-breasted Warbler (*Dendroica castanea*)	221	9.13
Oven-bird (*Seiurus aurocapillus*)	84	3.47
Northern Water-thrush (*Seiurus noveboracensis*)	4	0.17
Kentucky Warbler (*Oporornis formosus*)	10	0.41
Mourning Warbler (*Oporornis philadelphia*)	1	0.04
Yellow-throat (*Geothlypis trichas*)	405	16.73
Hooded Warbler (*Wilsonia citrina*)	2	0.08
American Redstart (*Setophaga ruticilla*)	123	5.08
Orchard Oriole (*Icterus spurius*)	1	0.04
Baltimore Oriole (*Icterus galbula*)	1	0.04
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	3	0.12
Blue Grosbeak (*Guiraca caerulea*)	1	0.04
Indigo Bunting (*Passerina cyanea*)	24	0.99
Dickcissel (*Spiza americana*)	2	0.08
Lincoln's Sparrow (*Melospiza lincolnii*)	3	0.12
Total number of species—39	2421	99.99

by actual count plus an estimated 100 on the pavement side of the pole where the bodies were too crushed by traffic to get an exact count. Multiply this by the ten light poles in the area and you get a conservative figure of 10,000 dead birds. It is conservative because it does not take into account the many dead and injured birds already covered by the blowing sands, those eaten by the gulls and the crabs, or the hundreds that died after being rescued. In many instances we found only one or two bright feathers left uncovered by the wind and sand; large flocks of gulls fed in the area all day.

We wanted specimens for study skins, and others for closer examination so we worked until almost dark picking up specimens at random in addition to the ones we had collected and counted from the one light pole.

We found later that we had collected over 2,400 specimens which represented 39 species (Table 1). The majority was made up of warblers (95.35 per cent) but there were also 20 other species listed. There was obviously more than one race among the Yellow-throats, and, according to Dr. Gabrielson, possibly two races of the Oven-birds and the Redstarts. At present subspecific identification of the birds has not been completed.

Of the birds rescued by Mr. David Lebby at the Park, about 100 were given to the San Antonio Zoo and of the remainder, my students and I banded and released 180 warblers of 11 species. We were careful to band only birds that were apparently healthy and unharmed by their capture.

Acknowledgments

Mr. Ed Elmore, area representative of the U.S. Fish and Wildlife Service, and Mr. David Lebby, Manager of the Nueces County Park, cooperated in making it possible for us to collect data for this report. I would also like to acknowledge the assistance of Dr. Ira N. Gabrielson for verifying the identification of certain species; L. Irby Davis for the critical reading of the report; Arturo Garcia, Delia Gonzalez, Alonzo Lopez, and Barbara Everhart for assistance in collecting and banding of birds and Miss Everhart for further assistance in working with the specimens and preparing the data.

Science Division, Pan American College, Edinburg, Texas, September 21, 1955

RE-ESTABLISHMENT OF BREEDING POPULATIONS OF LONG-BILLED CURLEWS IN WASHINGTON

BY CHARLES F. YOCOM

EARLY travelers through the Columbia Plateau of eastern Washington mention seeing many curlews, and settlers knew them well by their calls which the birds made on their nesting grounds in the rolling grasslands, sagebrush plains, and channeled scablands. The name Curlew Lake in Ferry County suggests that these birds frequented that area; they were known to occur in the Okanogan and Yakima Valleys also.

Apparently man was responsible for the decline in the populations of curlews that occurred with settlement. The birds were shot for food and their nesting areas were destroyed when much of the range land eventually was plowed under and planted to grain. Within recent years, the populations have increased in some of the grassland ranges. Figure 1 shows typical breeding habitat for Long-billed Curlews (*Numenius americanus*) in eastern Washington.

Changes in land use.—Settlements at the end of the last century were located along streams or near lakes, and often they were adjacent to yellow pine (*Pinus ponderosa*) timber. Human populations grew, and later more of the range lands formerly under the control of cattlemen were invaded by farmers. The better grasslands were continually being plowed, and homesteaders even invaded the scablands. So, for a time, rural populations grew, only to diminish as the more successful operators bought out those who were less successful or who desired to move elsewhere. Small holdings were not economically sound for the owners; thus large economic units developed.

Evidence of the reduced rural populations is obvious in the deserted country schools and old homestead sites. Data for Whitman County (Yocom, 1943), showing that private land holdings increased from 495.5 acres per unit in 1930 to 532.9 acres by 1940, also indicate that this trend started during the homestead era (Yocom, 1952). Buss and Dziedzic (1955) show how increase in cultivation of the rich Palouse country effected a decline in Sharp-tailed Grouse (*Pedioecetes phasianellus*).

After homesteaders moved out of the poorer soils, cattlemen again obtained control of most of the channeled scablands, thus placing the range lands under large operating units and permitting revegetation. This trend, in addition to better range management, may have affected the increase of curlews. These assumptions concerning factors that have affected populations of the Long-billed Curlew are subject to question, but whatever the cause, this species has increased in eastern Washington in recent years.

FIG. 1. Breeding habitat of the Long-billed Curlew in the channeled scablands of eastern Adams County, Washington. The loess hills in the background are cultivated for wheat production.

RECORDS BY COUNTIES

Okanogan County.—Curlews nested in pasture land directly east of Lake Osoyoos on the Eder Ranch, spring of 1953.

Grant County.—There are no breeding records for this county. Sight records include two curlews seen on July 7, 1950, and two on May 6, 1951, in Potholes south of Moses Lake; one at Lake Lenore April 7, 1952 (Harris and Yocom, 1952); two, June 8; and one, August 4, 1954 (Johnsgard, 1954).

Lincoln County.—There are no published breeding records for this county. H. A. Hansen reported the following observations from the shallow, temporary marshland at the east end of Sprague Lake: one, March 22, 1949; two, March 25, 1949; three, March 30, 1949; two, July 19, 1949; five, May 5, 1950.

Spokane County.—H. A. Hansen found curlews breeding in the dry range lands directly east of Sprague Lake and west of Downs Lake, Spokane County, in 1950.

Adams County.—The eastern edge of Adams County, which lies in the Cheney-Palouse River Channel and is drained by Cow and Rock creeks (Yocom, 1951:53), supports many Long-billed Curlews. A sizable population nests at the west end of Sprague Lake in rolling range land. In 1947, John Harder stated that curlews were becoming more abundant on their 80,000-acre ranch along Cow Creek, which drains Sprague Lake. When he was a boy only scattered pairs were seen on the ranch; now they are common and breed at lower Sprague Lake and along Cow Creek east of Ritzville. LaFave (1954) found two young birds about three weeks old and saw eight pairs near Sprague Lake on May 29, 1954.

Another concentration center is near Twelve-mile Slough which is located northeast

of Benge. East of this marsh on the Hodge's ranch, a pair was seen in 1947. By April 13, 1951, this population had increased to the point where the writer was able to count 18 adult birds in driving one mile through this rangeland. Elsewhere in Adams County this species has been reported during the breeding season by Hansen at Palm Lake, on rangeland north of Benge, at the Harry Harder Ranch near Lamont, and at Emden. Yocom noted a concentration of 150 at Twelve-mile Slough, July 13, 1949, and has seen curlews at Cow Lake, and at a small pond west of Macall.

Whitman County.—Whitman County encompasses the greater part of the land drained by the Palouse River (Yocom, 1943:169) and is actually the heart of the "Palouse Country" or the "Palouse Hills." Curlews nested in this county before the grasslands were converted to wheat fields, but it is not known how extensive the nesting populations were.

Evidence to support the above statement came from interviews with qualified observers. In 1949 Mr. William Hegler, former County Game Commissioner, stated that curlews were seen in the St. John area several years ago, but it was not known if they nested in this portion of the county.

Mr. Christenson, who lived near Cherry Lake south of Ewan for many years, related that there were many curlews which nested in this channeled area of western Whitman County in the early days. None is nesting in that area at the present time as far as the writer knows.

Other reports indicated that curlews nested along Alkali Creek west to the LaCrosse area at the time that the greatest extent of the range land was plowed under.

Recent information shows that curlews are again nesting in some areas of Whitman County where they formerly nested. Fay Lloyd was raised along the lower Palouse River and he observed these birds nesting in the range lands in the vicinity of Twin Buttes, which are about five miles south of Hooper, from 1909 to 1914. No curlews were seen again in this area by him until the spring of 1947 or 1948. Since then he has observed curlews every spring in this area. Three birds were seen at Twin Buttes on March 31, 1951, by the writer.

Suitable breeding areas still remain along the Palouse River from Winona to Hooper. The following recent records suggest that Long-billed Curlews breed in that area: one bird seen flying east over the Palouse River two miles south of the mouth of Union Flat Creek, April 2, 1948, (Hansen and Yocom); three curlews seen along the Palouse River northwest of Pampa, April 20, 1951.

Walla Walla County.—Records for this county are those of Carl V. Swanson, Game Biologist, State of Washington Department of Game: one near Burbank, April 1, 1947; two, two miles north of Touchet, April 25, 1947, and one seen in same locality on April 21, 1948; one adult and three young about the size of a Killdeer (*Charadrius vociferus*) between Burbank and Wallula, May 17, 1947. Swanson (personal communication, 1955) saw seven Long-billed Curlews in typical grassland habitat seven miles east of Burbank, June 6, 1955.

E. S. Booth (Hudson and Yocom, 1954) indicated that curlews were locally common near the Columbia River between Touchet, Wallula and Pasco.

Franklin County.—Mr. Oscar Rogers homesteaded the first wheat farm east of Pasco, Washington, in 1897 and at that time curlews were abundant. Farming practices and increased human populations reduced these populations (Swanson, 1955, personal communication).

The following records for this county are those furnished by Carl V. Swanson: Curlews seen approximately 15 miles northwest of Pasco near Byers Landing (now known as

the Pasco Pumping Plant) in 1947; several birds seen east of Pasco along the Snake River in the 1930's during a Mormon cricket outbreak; four seen five miles east of Pasco about one-half mile from the Snake River, June 7, 1955; 30 or more curlews seen by Charles Swanson flying about near a grass fire east of Pasco on June 12, 1955. Possibly young birds that could not fly were in these grasslands.

Curlews arrive on the breeding grounds as early as March 22 (Hansen) and depart during the month of July. The latest date that this species has been seen in eastern Washington is July 21 (Hudson and Yocom, 1954). The writer hopes that interested people in Washington continue to follow population changes in Long-billed Curlews in the future.

Summary

Early records show that Long-billed Curlews were found at a number of localities in the Palouse prairie region of eastern Washington. These birds disappeared as the grasslands were plowed under, but they have reappeared with changes in land use. Distributional data tracing these population trends are listed by counties.

At the present time breeding populations are scattered over the lower portion of the Cheney-Palouse River Channel south of the yellow pine zone; this area includes parts of Whitman, Adams, Spokane and Lincoln counties (Yocom 1951:52–56). Other population centers are located along the lower Snake River and the Columbia River in Franklin and Walla Walla counties.

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Department of Game Management, Humboldt State College, Arcata, California, October 25, 1955

JUVENILE MORTALITY IN A RING-BILLED GULL COLONY

BY JOHN T. EMLEN, JR.

COLONIAL sea birds are characteristically long lived once they have fledged, but the period from hatching to fledging is a critical one in which heavy mortality may occur. The nature and circumstances of juvenile mortality was one of the objectives of a study of nesting Ring-billed Gulls (*Larus delawarensis*) made on Green Island in Mackinack Straits, Michigan, in July of 1952 by Mr. Carl Jacoby and the author. Supplementary observations were made by the author in June, 1953, and June, 1955.

I am much obliged to Dr. Joseph J. Hickey for a critical reading of the manuscript and for helpful suggestions on the handling of the statistics.

Green Island in 1952 was a narrow "J"-shaped sand and gravel bar about ½ mile in length, covered for the most part with a dense growth of grasses and shrubs. The main part of the island was inhabited by Herring Gulls (*Larus argentatus*) whose nests were scattered at intervals of two to ten meters among the grasses, weeds and driftwood behind the beaches. An oval-shaped area constituting the hook of the "J" was occupied by a nesting colony of about 850 pairs of Ring-billed Gulls crowded into a space of about 1200 square meters with nests often only about 0.45 meters apart (center to center). The central part of the Ring-bill colony was essentially without bushes, and by July the grass vegetation had been heavily trampled and puddled by the birds. A broad zone of low scrubby bushes of *Cornus stolonifera* with a moderate understory of grasses (*Elymus canadensis*) surrounded this central barren.

Casual observations made on walking through the colony on July 2 revealed many dead chicks of various sizes and in various stages of decay. In order to quantitate this mortality, four plots each three meters on a side were staked out at representative points in the colony. Blinds were set up at the edge of two of these plots for direct observation of the birds. A number of chicks resident in the plots were painted on the legs for individual identification, and adults were sprayed with colored India ink shot from a water pistol by the observer in the blind. Dead chicks were collected from the plots, counted, and measured for rough age determination.

STATISTICAL RESULTS

A total of 37 dead chicks was collected from the 36 square meters of the four plots. Since territory size on 20 square meters watched from blinds during the incubation stage (1953) averaged 1.2 square meters, the number of initial territories present on the four plots in 1952 was about 30, and the indicated juvenile mortality was approximately 1.25 birds per territory. A plotting of the size distribution of these dead birds as measured by tarsal

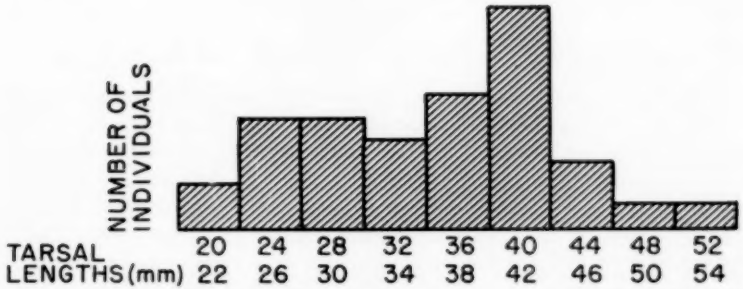

FIG. 1. Representation of age categories (by tarsal length) among Ring-billed Gull chicks picked up dead in the nesting colony.

length (Figure 1) indicates a distributed mortality with the greatest losses occurring in the middle size group, birds which were large enough to wander from the home territory but too small to protect themselves effectively. On the basis of this mortality curve it seems likely that deaths subsequent to our check (determined as at approximately the two-thirds point of the nesting stage) amounted to about five birds on the 36 square meters bringing the estimated total of deaths of juveniles on this area to 42, and the mortality per original territory to 1.40 for the season. This is actually a minimum figure since it excludes all deaths for which the carcasses were removed or obliterated by scavengers; Herring Gulls were observed to eat a number of Ring-bill chicks at the colony edge, and adult Ring-bills themselves were suspected of occasional cannibalism. Thus the actual figure probably approximates or exceeds 1.50.

Surviving chicks were estimated on July 5 and July 11, 1952, on the basis of observations made from blinds on 16 territories. The number of young birds on these 16 territories was 21, an average of 1.3 per territory. One of these had 3 young, three had 2 and twelve had 1. The absence from this tally of territories with no young is no indication that complete brood loss does not occur, since destitute parents apparently abandon their territories and do not return to build new nests as has been reported for the Herring Gull by Paludan (1951). The increase in average territory size in the colony center from 1.2 square meters during incubation (June, 1953) to 2.0 in the latter part of the nestling stage (July, 1952) is thought to reflect the occurrence of such nest failures. If we assume that complete losses of this order of magnitude did occur in 1952 before our counts were made, the 21 chicks recorded actually represent the survival of $\frac{2.0}{1.2} \times 16$, or 27 instead of 16 pairs. This survival should be further revised on the basis of mortality occurring in the last one-third of pre-fledging life, after our

TABLE 1

NESTING SUCCESS AT THE GREEN ISLAND RING-BILLED GULL COLONY IN 1952

	No. of pairs (out of 100)	Eggs Produced a	Eggs Hatched	Chicks Fledged	Eggs Lost	Chicks Lost
	A	B	C	D	E	F
Successful	60[b]	180[c]	?	67 (37%)	?	?
Unsuccessful	40[b]	120[c]	?	0	?	?
Total	100	300[c]	217[e]	67[d] (22%)	83[f]	150[d]

a—Refers to the final clutch when re-laying occurs.
b—Based on increase in territory size of persisting pairs from 1.2 square meters in egg stage to 2.0 square meters in nestling stage.
c—based on an assumed clutch size of 3.0.
d—Measurements made on sample plots.
e—Sum of totals of columns D and F.
f—Difference between columns B and C.

checks were made. According to our data in Figure 1, this would amount to about three birds. Actual survival to fledging in the colony in 1952 was thus apparently in the order of $^{18}/_{27}$, or 0.67 young birds per pair that started the nesting season.

No data are available on clutch size in the Green Island colony in 1952, but it was 2.9 in 1953 (20 nests, mostly in mid- or late-incubation). Full clutches are recorded in the literature as generally 3. The occasional clutches of 2 may often result from losses during incubation, and the rare reports of 4, 5 or 6 may well represent irregular deposition in nests by more than one female. Our findings of about 1.50 deaths and 0.67 survivals per pair seem to indicate a hatch of about 72 per cent of eggs laid (assuming a clutch of 3.0) and a survival to fledging of about 22 per cent of eggs laid and 31 per cent of eggs hatched. Within the group which was successful in raising at least one chick the survival to fledging was 37 per cent of eggs laid (Table 1). Repeat laying is known to occur in several species of gulls after loss of the first set, and our figures must be interpreted as representing survival from the eggs of the final clutch if and when more than one was produced.

OBSERVATIONS ON BEHAVIOR

A strong development of territorial defense in these birds seems to account for most of the mortality observed. A detailed mapping of territories on the plots watched from blinds indicated that, until their chicks were fledged, each pair of adult Ring-bills vigorously defended a territory around the nest site against all intruders, both young and old. Even small chicks trespassing within these bounds were vigorously attacked and in many instances killed directly. Older chicks took part in the territorial activity, attacking

other young birds and even adults much larger than themselves. Trespassers were almost invariably subordinate in these encounters and retreated submissively.

Territorial boundaries remained definite and were well recognized by both owners and neighboring residents long after the young had hatched and scattered or trampled the crude nest into obliteration. Generally, at least one member of a pair was on hand, but there were many occasions when both birds were absent and the territory left undefended. At such times, neighboring adults characteristically extended their proprietary activity to include the temporarily deserted area, and in so doing frequently attacked the resident young birds. The first adult birds to return after a general exodus from the colony (as when flushed by the observer) freely occupied and defended an area encompassing as many as three or four adjacent territories until their neighbors had returned and claimed their own. Under such circumstances confusion reigned, and chicks were obliged to crouch or be severely buffeted until their parents returned.

The frequency of attacks increased as chicks became more independent and wandered beyond the boundaries of the parents' territories. Half-grown chicks often wandered off voluntarily, especially when their territories possessed no shade, to gather with others of similar age into groups of a dozen or more individuals under the bushes. However, feeding by the parents generally, if not invariably, took place on the home territory, and the chicks were often obliged to run a gauntlet of vicious attacks through three or four territories before reaching home. The greatest mortality occurred at this stage. Older chicks wandered much farther afield, even swam as much as 100 meters out into the lake for periods of four hours or more. Homing orientation developed concurrently and the return trip often involved the traversing of considerable stretches of occupied territory in which attacks were frequent and vicious. By this time, however, the birds were better able to care for themselves and fatal injury was apparently infrequent (Figure 1).

Aside from the infanticide described above, the only agent of mortality detected was the Herring Gull. The two gull species had divided the island between them, and segregation was complete except for a few Herring Gulls which periodically established beach-heads along the shore line bordering the Ring-bill colony. These birds wandered back and forth along the beach, occasionally penetrating a few feet inland and snatching any Ring-bill chicks which ventured within their reach. We watched about half-a-dozen chicks being killed in this way, but do not believe it was a major factor in the total mortality. In 1953 one pair of Herring Gulls actually established a territory at the edge of the Ring-bill colony and destroyed a considerable number of chicks. It is interesting and perhaps significant that Herring Gulls

characteristically ate chicks which they killed or found dead, while Ring-bills were never observed to eat the chicks they killed.

The general picture of chick destruction here depicted is similar to the situation described by Kirkman (1937) in the Black-headed Gull (*Larus ridibundus*), which, like the Ring-bill, nests in crowded colonies. Similar, though perhaps less severe, persecution of young is apparently characteristic of various other species of gulls.

Discussion

The production of 0.67 fledged young per breeding pair in the Green Island Ring-bill colony would at first appear to be low and perhaps to suggest abnormal conditions for survival. Data on adult mortality rates could provide a basis for evaluating this production by indicating the recruitment rate necessary to maintain the population. Published analyses of banding data on this species (Ludwig, 1943) are, however, inadequate for these purposes.

Although we lack the necessary data for evaluating fledging rates in the Ring-bill, it is profitable to examine the available records for the closely-related Herring Gull. Studies of nesting success in Maine by Paynter (1949) revealed a fledging rate of slightly less than 1.0 birds per nesting pair. In Europe Paludan (1951) obtained figures of 0.5 or less in Denmark; Darling (1938) had 0.78 in his studies in 1936 and 0.96 in 1937 in Scotland; Lockley found a production of less than 0.33 fledgings per pair on Skokholm in Wales.

Marshall (1947), Paynter (1947, 1949), Paludan (1951) and Hickey (1952) have analysed banding returns on the Herring Gull for information on adult mortality and population turnover rates. Their results have been distressingly variable. In general the American studies have produced results which call for recruitment rates in the order of 1.0 to 1.5 per breeding pair per year, while Paludan's studies of birds banded in Denmark show lower adult mortality and hence imply lower recruitment rates. Paludan demonstrates that with the 15 per cent annual mortality of adult gulls from Denmark, each nesting pair would have to produce only 0.5 to 1.0 fledglings per year to maintain the population. Hickey (1952) in evaluating the discrepancies between results obtained by American and European workers proposes that the differences are at least in part attributable to the inferior wearing qualities of the American bands, and concludes that the Danish figures are more reliable. However, Paludan (1951) questions this interpretation because of the similarities of shape of the two mortality curves. In any event, our fledging rate of 0.67 per year for the Green Island Ring-bill gull chicks does not appear to be far out of line with the performance of at least some populations of Herring Gulls.

Even though the fledgling survival of the Green Island colony be essentially normal, it is profitable to speculate on factors affecting the chick mortality. Young Ring-bills seem to be able to absorb a great deal of physical punishment, but any extraneous factor which might serve to accentuate the aggressive attacks of territorial defenders or to lower the resistance of the chicks might have serious effects on survival of juveniles. Two such factors appear to contribute importantly to the infanticidal destruction of young birds in the Green Island colony. These were: 1) scarcity of shade in the central area, and 2) disturbance of territorial stability by nonavian intruders.

As already noted, nearly all of the grassy vegetation present in the central part of the colony at the beginning of nesting was obliterated by early July through puddling and trampling by the nesting birds. The flats exposed by this denudation were largely abandoned by chicks almost as soon as they could walk, and were quite uninhabited during the intense heat of mid-day. Recently-hatched chicks in one nest close to a blind succumbed after three hours of direct exposure to the noon-day sun and were subsequently pecked and tossed aside. Young birds only a few days out of the egg sought the shade of nearby bushes and the associated grass tufts when their parents were away; they commonly crowded into the shade of our blinds and even crawled into them under the sides. Aside from the occasional direct death, the effects of this exposure to intense solar heat would undoubtedly weaken the birds and reduce their resistance to the rough treatment they receive as they return home.

Also important were the effects of disturbances of territorial stability caused by human intruders. Young birds of all ages readily leave their territories on disturbance and may be driven from their homes for distances of many meters. The return of the adults may be inordinately prolonged by the continued presence of the intruder, but more important, the young are eventually obliged to return through a series of territories occupied by vicious defenders. Many of the young, indeed, may fail to find their way back at all. Of six medium-sized chicks painted for individual recognition and released on their home territories as I entered the colony on June 10, 1955, none returned the same day and four failed to return the second day. It is conceivable that these birds were fed by other adults elsewhere in the colony, but no evidence of such behavior was observed near the blinds. It is likely then that the disturbance created by our own intrusion into the colony significantly contributed to the mortality as here reported.

Summary

Juvenile mortality was measured, and mortality factors were studied, in an island colony of 850 pairs of Ring-billed Gulls in northern Michigan.

Thirty-seven carcasses of dead juvenile gulls were collected in plots cover-

ing 36 square meters of the colony area, indicating a total mortality, when corrected for subsequent deaths, of about 1.50 chicks per nesting territory. All size classes were represented among the carcasses collected, but the highest mortality apparently occurred in middle-sized birds, those large enough to move away from the nest but too small to defend themselves effectively against adult attack. Counts of chicks on two study plots revealed about 0.67 survivors per territory at fledging. Comparison with published data on the Herring Gull suggests that this low production rate may be adequate to maintain the population and hence normal for the species.

Vigorous defense of the small, tightly-massed territories against both young and old intruders was the direct cause of the great majority of juvenile deaths. Predation by Herring Gulls was a secondary factor.

Wandering of young from their territories during the absence of the parents indirectly contributed to juvenile mortality by necessitating returns for feeding through the defended territories of other birds. Destruction of shading vegetation and intrusion of the colony by human observers induced forced movements of chicks and thus aggravated the conditions producing mortality.

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January 10, 1956

OBSERVATIONS OF ELEGANT TERNS AT SAN DIEGO, CALIFORNIA

BY BURT L. MONROE, JR.

PRIOR to 1951 known occurrences of the Elegant Tern (*Thalasseus elegans*) in the United States were few, based on erratic wanderers from their nesting grounds along the Gulf of California in Mexico. Since 1951 records have shown that this tern has become regular and common on the southern California coast during the post-breeding season.

Occurrence of large numbers of this bird in southern California was first reported by Robert Pyle and Arnold Small (1951. *Audubon Field-Notes*, 5:308–309), who recorded 1100 individuals at Playa del Rey, Los Angeles County. There have been subsequent reports of Elegant Terns from this general area, but none exceeding 250 individuals.

The following article is based on observations of this tern on San Diego Bay, San Diego County, California, during the summer and fall seasons of 1953, 1954, and 1955.

METHODS

Observations during 1953 and through mid-August in 1954 were periodic, averaging about one every two weeks. However, from August 15, 1954, through the remainder of 1954 and through the 1955 season until September 1, daily studies were conducted at the U.S. Naval Training Center, San Diego. The Training Center is located at the northern tip of San Diego Bay and is one of the several concentration points for terns on the bay. Studies conducted there averaged about 45 minutes daily, and were made with good back or side lighting at a maximum range of 250 feet, usually much less. The data obtained there were supplemented by weekly observations on terns at other points on the bay, especially at the other known concentration points.

OCCURRENCE

I first encountered the Elegant Tern on September 21, 1953, among terns concentrated on the west side of San Diego Bay. This west border of the bay is a strip of land connecting Coronado, California, with the mainland to the south, and this particular tern concentration is situated on the south rim of the U.S. Naval Amphibious Base. More than 1000 terns were present on this date, and over one-half were Elegant Terns. The remainder were principally Forster's Terns (*Sterna forsteri*), with a small number of Common Terns (*Sterna hirundo*), Caspian Terns (*Hydroprogne caspia*), and Royal Terns (*Thalasseus maximus*).

After October 1, 1953, most of the Elegant Terns disappeared from this area, but scattered individuals were noted at many points along San Diego Bay until October 28.

In 1954 the Elegant Terns were first observed on July 18, when a group of 18 birds appeared on an exposed mud flat at the southern tip of the bay. Further observations during 1954 were impractical on my part until August 15, at which time I discovered the large concentration of terns on the U.S. Naval Training Center. On this date approximately 400 Elegant Terns were present, with a smaller number of the other four terns with this group. Virtually all detailed study of plumage, voice and behavior is based on observations of this concentration at the Training Center.

Continuing study of the group at the Training Center in 1954 showed an increase in number of individuals from 400 to a maximum of 600 on September 26. On this date I made another check of the group at the Amphibious Base and found well over 700 Elegant Terns there. The total number of Elegant Terns on the bay on this date was estimated at 1500 birds, and is a peak number for the entire three-year period of study. Numbers declined rapidly thereafter, leaving only 275 at the Training Center on October 2, 20 on October 31, four on November 22, and two on December 1, the latest recorded in 1954.

Prompted by the rather astounding numbers of these terns in 1954, I decided to make a very close study of the Training Center concentration in 1955, to determine fluctuations in the population and to study closely the behavior of these terns, very little having been done on this species in the past.

Two adult Elegant Terns in breeding plumage, a truly beautiful sight, appeared among the nesting Caspian Terns on the southern end of the bay on June 18, 1955. This marks the earliest occurrence in this country and indicates the possibility of nesting here in the future. However, as mentioned in Bent (1921. *U.S. Nat. Mus. Bull.*, 113:220), the known egg dates of this bird are for early April, so the probability at present is small.

Small numbers of Elegant Terns began to appear at various points on the bay after July 2, and the first individual appeared at the Training Center on July 16. A very gradual buildup of numbers took place at the Training Center, reaching 60 terns on August 18. A definite influx then began, reaching 149 by August 26 and a maximum of 294 on September 1, the final day of observation by the writer in 1955.

On September 1, a complete survey of the bay was made, and the estimated number of Elegant Terns was placed around 700 birds. This is slightly below the total for the same time in 1954.

C. H. Channing, of San Diego, informed me (*in litt.*) that three Elegant Terns remained at the Training Center until January 2, 1956. This is by far the latest occurrence ever recorded in this country.

Plumage

In breeding plumage there is probably no more spectacular a tern than

the Elegant. The rosy underparts and orange-red bill set it apart from any other tern. The only birds observed in full breeding plumage were the ones seen on June 18 and on July 2, 1955.

All adults after July 2 appeared in various plumage stages from partial breeding to full winter. This transition is marked by the molt of the black forehead feathers and subsequent replacement with white, as in the Royal Tern and Cabot's or Sandwich Tern (*Thalasseus sandvicensis*), and the disappearance of the rosy bloom on the underparts. The former occurs first, with birds on July 18 with much white on the forehead. By August 5, at least 50 percent of the birds at the Training Center possessed completely-white foreheads (this white extending back on the top of the head just behind eye, as in the Cabot's Tern, but not as far back as in the Royal). By August 14, only 5 per cent of the adults were not in complete winter plumage, as far as the forehead goes. On the other hand, many individuals retained their rosy bloom into early September, the last bird on which it was discernible in the field being observed on September 7.

Once the rosy bloom has disappeared, the birds are not as easily distinguished in the field. If one consults present-day field guides, passages such as "similar to Royal Tern, but smaller," or "one should not attempt to distinguish this species until he knows the Caspian and Royal completely" are encountered. This is not of much help to the field observer and it is not a true picture of the situation, for the Elegant Tern is distinguished from the two larger terns much as the Cabot's Tern is along the Gulf of Mexico, with the exception of bill color.

In addition to smaller size, the Elegant is slimmer, more graceful in flight, and usually has a more rapid wing-beat. As in the Cabot's Tern the proportionately-slim bill is noticeable, although the color in the Elegant Tern parallels that of the Royal. The most distinctive field character is the crest, which is longer and more extensively black than that of the Royal. When the tern is at rest the crest feathers tend to lie down along the nape unless ruffled by the wind or erected by the birds. But the crest of the Royal Tern is shorter and tends to remain erect even when the bird is resting. Further, the black of the crest begins at a point just above the eye in the Elegant, and is not intermixed with white feathers, while in the Royal Tern the white feathers of the forehead extend much behind the eye and usually intermix with the black feathers of the crest, giving a grayish appearance to the crest. I use the term "usually" here because this crest character is not evident in Royal Terns of the coast of the Gulf of Mexico, but is evident in all the Royal Terns of the Pacific coast which I have observed or examined.

The primaries of the Elegant Tern normally show more black above than the Royal, but this is not a reliable character, especially in immature birds.

Color variation of the bill of Elegant Terns is much greater than in either the Royal or Caspian Tern. Adult Royal Terns have orange-red bills, adult Caspians have carmine-red bills, the variation in these colors among individuals being very slight. On the other hand, the Elegant Tern's bill varies from a light yellow-orange to a deep orange-red, the most frequent condition being orange-red as in the Royal. In immatures there is an even greater variation, as is discussed later.

The most remarkable feature of the coloration that I observed was the foot color. The normal foot color (in about 90 per cent of the adults) is black, as in all other terns. However, about 10 per cent possess *bright orange* feet and legs. I first noticed this odd foot color in late August, 1954, at the Training Center. A close check revealed at least fifteen individuals with completely orange feet and legs, and another ten with partially orange feet and legs. In no other way were these birds different from typical black-legged adults. To my knowledge, there is no mention in the literature of this color variation.

Orange-legged adult Elegant Terns again appeared at the Training Center in August, 1955. Since collecting is out of the question there, color photographs were secured of several of these orange-legged adults. Although somewhat unsatisfactory, due to the distance involved, these photographs are sufficient to show the foot color.

The immature plumage, with the exception of bill and foot color, is similar to that of the Royal Tern. It differs from the adult in the presence of dark coloring in the secondaries, upper wing coverts, and rectrices. However, this dark coloring is not as pronounced as in Royal Tern immatures, and in a few immature Elegants is barely discernible.

Foot and bill colors are quite variable in immatures, but generally run paler than in adults. Typical immature bill color is yellow (about 60 per cent of immatures observed), ranging from a pale straw color to light orange-red. Foot color is usually greenish or greenish-black (about half the birds observed), ranging from bright yellow-orange to black.

Very few immatures and none of the adults possessed dusky-tipped bills, in which cases the dusky was restricted to the very tip. All Elegant Terns observed, immature or adult, had bills appearing totally yellow or orange at a moderate distance.

The remainder of the immature plumage, including head feathers and crest, is similar to the adult winter plumage.

Voice

The voice of the Elegant Tern is distinctive, if one is familiar with that of the Royal Tern. It is higher pitched and less harsh, a rather clear *ke-e-e-r*, dropping very slightly in pitch toward the end. Of course, it is

totally unlike the grating, low-pitched *kra-a-ak* of the Caspian, or the *kri-i-ick* of the Cabot's.

Both adults and immatures are also very noisy when sitting in flocks. The sound emitted from a flock of 100 birds sounds very much like a hatchery, with myriads of baby chicks constantly peeping. I have heard groups of Royal and Cabot's terns produce a similar sound on the coast of the Gulf of Mexico, but it is not quite so chick-like in these two terns. This sound is usually given incessantly by a group of Elegant Terns, and often an observer is unaware of the noise, for it is high-pitched and constant; this situation is much the same as arises with large flocks of Cedar Waxwings (*Bombycilla cedrorum*) producing high-pitched notes near the upper limit of human hearing range.

The peeping sound is given most notably by immatures begging for food, or by adults engaging in residual nesting activity, as discussed later.

In regards to voice, it might be well to mention here that I have noted Caspian Terns in flight emitting a high-pitched *pe-e-e-e*, drawn out and on the same pitch. I believe only immature Caspian Terns do this, but I am not positive of this. I am unaware of reports mentioning any high-pitched sounds of this nature by Caspian Terns.

Behavior

The Elegant Tern was observed feeding most commonly in quiet waters of lagoons or along the shores of the bay, rather than out in the rougher open water of San Diego Bay. Most observations of feeding at the Training Center indicated that the birds flew along at heights of from two to ten feet above the water, then plunged down after small fish. When feeding in this manner, Elegant Terns have a rapid wing-beat and hover often, much as the Forster's Terns do. In fact, if one is down-sun from the birds or directly behind them, it is easy to mistake the Elegant for a Forster's. However, when not engaged in feeding, the wing-beats are slower and the birds can be mistaken for Royal Terns if no size comparison is available and the head and bill cannot be seen in profile.

While at rest the Elegants normally concentrate in large groups, although scattered individuals among a mixed flock of terns may be the case. It is in these large groups that the residual nesting activity occurs. This phenomenon was also observed by Pyle and Small (*op. cit.*) and recorded as such, but not described.

Immatures continue begging for food, and have been noted doing so into late November. Begging is accomplished exactly as in the Royal Tern. The immature bird, upon arrival of an adult with food, lowers its head, thereby erecting the crest feathers, chases the adult with head low and slightly uptilted, and peeps continuously until fed.

Activity, which could only be residual courtship activity, was also observed among the adults as late as October 15, 1954. Usually three adults took part at once, but occasionally only two birds participated. These terns would run along side by side for a few feet, with their wings extended down and away from the body anteriorly, but with the tips still crossed over the back. The neck was stretched upward as far as possible during the performance and the bill alternately raised and lowered from the horizontal up to an angle of about 75° and back to the horizontal. Each time the bill was elevated to the high angle, the peeping sound was given. It should be pointed out that the two or three birds taking part in each activity normally raised and lowered their bills in unison, or very nearly so.

I noticed that the Elegant Terns would sleep, or at least close their eyes, while in a position of rest commonly observed in other terns. That is, they would rest on their bellies with their heads stretched forward and their bills lying flush with the ground.

Bathing by Elegant Terns in shallow water was also observed at the Training Center.

Acknowledgments

I wish to express my appreciation to Paul E. Popejoy, Harriet M. Popejoy, and William F. Reeves, for their help in securing photographs of the Elegant Terns at the Training Center, and to E. C. Trowbridge, C. H. Channing, and Mrs. T. H. Brown for their assistance with this study. All are members of the San Diego Audubon Society.

BTU-1-S, NAAS, Whiting Field, Milton, Florida, November 1, 1955

THE WILSON ORNITHOLOGICAL SOCIETY LIBRARY

The following gifts have been recently received. From:

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GENERAL NOTES

Long-tailed Jaeger in Kansas.—On June 22, 1955, we saw a jaeger at Cheyenne Bottoms, a natural swamp converted into an artificial reservoir, 6 miles east and 3 miles south of Hoisington, Barton County, Kansas. Our efforts to collect the bird finally drove it from the area. We returned to the same place on June 23, found the bird again, and collected it.

The specimen (KU 32610) proved to be an adult female Long-tailed Jaeger (*Stercorarius longicaudus*). It was very fat, had light blue tarsi and black feet, and was in "normal" (that is, light) plumage phase. Measurements were: wing, 287 mm.; tail, 260 mm.; tarsus, 44 mm.; middle toe (without claw), 31 mm.; exposed culmen, 28.5 mm.; cere, 13.6 mm.; dertrum, 15.8 mm.; depth of bill at base, 10.3 mm.; width of bill at base, 9.1 mm., and middle rectrices projecting 124 mm. beyond adjacent pair.

The specimen represents the only record of the species in Kansas. There is, however, one record for the Pomarine Jaeger (*Stercorarius pomarinus*) from the state. This record of the Long-tailed Jaeger is of interest in relation to the overland, continental migration suggested for the species by some authors (Murphy, 1936. "Oceanic Birds of South America," vol. 2:1039). It should be noted, however, that inland records of the species in North America are too few to suggest any substantial inland migration. The late date of the record here reported suggests that the bird might not have been migrating northward to breed. Unfortunately, no record was kept of the condition of the ovary.—Larry D. Mosby and William M. Lynn, *State Biological Survey, University of Kansas, Lawrence, Kansas, November 3, 1955.*

Nocturnal predation on Song Sparrow eggs by milksnake.—On June 25, 1955, at Camp Arbutus, near Traverse City, Grand Traverse County, Michigan, a nest of a Song Sparrow (*Melospiza melodia*) was discovered. The nest was 15 inches above the ground in a low evergreen (*Juniperus* sp.). It was in such an open situation that I had been able to make hourly observations on it and was able to watch the entire construction and subsequent deposition of eggs.

On July 1 incubation of the three-egg clutch began. On the afternoon of July 3 an adult bird was still incubating the eggs. At 10:00 p.m. my wife and I visited the nest and found a 30-inch Milksnake (*Lampropeltis doliata*) coiled around the nest rim. Only one egg, still warm, remained in the nest. The adult sparrows were not seen nor heard. Our flashlight did not seem to disturb the snake, but it dropped to the ground when I reached out to capture it. We left the nest and returned five minutes later. The snake had returned and was in the process of grasping the egg with its mouth. After two attempts at engulfing the egg, the snake succeeded in getting it entirely in its mouth. The snake was then captured and the unbroken egg was removed and placed back in the nest. The adult sparrows never returned to the nest.

More nocturnal observations on the nest life of birds need to be made in order to determine the extent of predation on eggs, young, and even adult birds.—Harold D. Mahan, *421 W. Jefferson, Ann Arbor, Michigan, November 7, 1955.*

Cape May Warbler summering in lower Michigan.—The Cape May Warbler (*Dendroica tigrina*) passed through southern Michigan earlier than usual in the spring of 1955 (although no early records were broken). Males appeared in the Ann Arbor region on May 5, 6, and 7 (L. C. Binford, D. A. Zimmerman), and a female on May 12

(Zimmerman). Binford last saw the species at Point Pelee, Ontario, May 14. Numerous observers in the field during the last two weeks of the month did not report the species. Therefore, I was surprised to find four singing male Cape May Warblers in a spruce bog in Oscoda County, Michigan, on June 4. The exact location was T. 28 N., R. 1 E., Section 12, three miles northeast of Red Oak. The birds did not behave like migrants. Each acted as if on territory, singing persistently from one or a few perches for long periods of time. Later in the day Marian Zimmerman and I collected a singing male (UMMZ 136,505) with enlarged testes in another spruce bog near Luzerne, 12 miles farther south.

The following morning Mr. and Mrs. Richard Zusi returned with us to the Red Oak region where we located seven singing males. One bird, watched for 30 minutes, spent most of his time foraging among the spruces (*Picea mariana*). He sang frequently (the usual *seet seet seet seet*, and a shorter, softer song: *sa-wit sa-wit sa-wit sa-wit*), but less often than the other males. We saw this individual carry food into a spruce top on one occasion. Another time it vigorously chased a second Cape May Warbler from a nearby tree and pursued it for an unknown distance into the swamp. Upon returning from the chase the bird sang once, then resumed feeding.

In a stand of spruce partially isolated from the rest of the bog we studied another male for nearly two hours. He was not very active, and sang or preened for many minutes at a time from one of three or four spruce-top perches within 150 feet of each other. We saw no female and searched unsuccessfully for nests in and near what we believed to be his territory. At least one other male sang frequently from not far away.

The songs of these birds seemed louder than those I have heard from migrating Cape May Warblers. They were the dominant sounds in this swamp, together with the songs of Golden-crowned Kinglets. They had surprisingly great carrying power.

One week later (June 12), Andrew J. Berger, Dr. and Mrs. Powell Cottrille, J. Van Tyne, and L. H. Walkinshaw watched these birds, but again no breeding evidence was obtained. However, Berger saw a female Cape May Warbler in the area on June 16.

N. A. Wood (1951. "The Birds of Michigan," p. 385) listed one summer record of this species from the Upper Peninsula (Luce County, 1941), and none at that season for Lower Michigan. According to O. E. Devitt (1950. *Canadian Field-Nat.*, 64:147), Dr. J. Murray Speirs observed a male Cape May Warbler on Beckwith Island, Simcoe County, Ontario, in July, 1948, marking "the most southerly summer occurrence for Ontario." Simcoe County is in approximately the same latitude as Oscoda County, Michigan.—DALE A. ZIMMERMAN, *University of Michigan Museum of Zoology, Ann Arbor, Michigan, December 10, 1955.*

The northernmost nesting of the Rough-legged Hawk in North America.—Among the ornithological surprises of my 1949 visit to Prince Patrick Island in Canada's Arctic Archipelago was the discovery of a pair of Rough-legged Hawks (*Buteo lagopus*) and their nest, hundreds of miles north of previously known nesting localities of the species. The northernmost summer specimens examined by Cade (1955. *Condor*, 57:316) in his review of the species came from Point Barrow, Alaska; Herschel Island, Yukon Territory; and Franklin Bay, southeastern Victoria Island, and southeastern Somerset Island, Northwest Territories, Canada.

The hawks were first noted on Prince Patrick on June 22 when I tramped inland to study nesting brant. The tundra was more than 80 per cent snow-covered, and snowshoes were still necessary for travel. Because valleys and ravines were flooded with meltwater, I was forced to go out of my way some distance up a stream to find a crossing, and thus came into an area that I had not previously examined (Fig. 1).

I was astounded when a large bird being harassed by a pair of Long-tailed Jaegers (*Stercorarius longicaudus*) proved to be a Rough-legged Hawk. Soon another appeared, and as I approached to within a quarter of a mile of an isolated, perpendicular-sided rock in a small canyon at the base of the mountain, the hawks began to attack me. This rock was about 1.6 miles inland from the frozen Mould Bay at approximately 76°21'20" N. latitude and 119°28'50" W. longitude.

FIG. 1. Nest site of a Rough-legged Hawk on Prince Patrick Island, Canada, viewed from a distance of about one mile. July 17, 1949.

Both hawks uttered repeated screams, somewhat like one of the screams of the jaeger, and one of the birds dived at me again and again as long as I remained in the vicinity. The other soared, hovered, and screamed, but never came very close to me. The plumage of both individuals was typical of the light extreme of *Buteo lagopus*. I had been previously acquainted with this species on its nesting grounds along the coast of Labrador and in southern Michigan where it is a common winter visitor.

I returned to the area on July 9 and found the suspected nest, about 30 feet from the ground, near the top of the perpendicular-sided rock (Fig. 2). Observed with binoculars from a distance of 10 or 15 yards, the nest appeared to be constructed of sticks and twigs, probably those of the prostrate willow (*Salix anglorum*), the only woody plant known to occur on Prince Patrick Island. Inasmuch as I found no trace of bones or animal remains beneath the nest, it is possible that it had been recently constructed.

On this occasion the brooding hawk left the nest when I was 300 or 400 yards from it and immediately launched an attack against me. It alternately hovered overhead, screaming, and swooped down-wind to within 30 or 40 yards of me. Its mate was content to hover screaming high in the air. It had only to flap its wings slightly to remain more or less stationary in the strong wind. The white bases of its primaries flashed brightly in the sunlight. The hawks possibly were molting on this date, for several flight feathers were missing from the wings of both individuals.

When I visited the place on July 17, the non-brooding hawk came screaming toward me while I was yet a mile from the nest. It dived at me half-heartedly a few times.

The other individual remained on the nest until I had been standing directly beneath it for several minutes. After it flushed, it soared screaming but did not dive. It showed more evidence of molt than the other bird. From a vantage point on the mountain slopes above the nest, I could see that it contained two eggs. In the nest rim was a fresh willow sprig with green leaves.

On this date I located a nest of the Long-tailed Jaeger about half a mile from the hawk nest (see figure in *Wilson Bull.*, 62:130, 1950). Both jaegers furiously attacked

FIG. 2. View of the rock column upon which the nest of a Rough-legged Hawk was located. July 17, 1949, Prince Patrick Island, Canada.

me when I was near their nest, but would leave me, even with my hand on the egg, to attack the Rough-legged Hawk whenever it came near. A resounding scraping of feathers several times indicated that they actually struck the hawk. In defense, the hawk hesitated in flight and turned open beak toward the jaegers when they came very close to it. The harassing tactics of the jaegers reminded me of those of the Eastern Kingbird (*Tyrannus tyrannus*).

When I visited the hawk nest again on August 16 I found it deserted and partially destroyed. The hawks were not to be found. Only birds or human-beings could have reached the nest. Ravens (*Corvus corax*), Glaucous Gulls (*Larus hyperboreus*), and jaegers had been seen in the neighborhood from time to time, and there were unaccountable tracks of human-beings in the vicinity.

Where the hawks hunted was an unsolved mystery. Although the nest was only about 3.5 miles from the Mould Bay Weather Station, the hawks were never seen there, nor for that matter, at any other point away from the immediate vicinity of the nest. No remains of prey were found. Varying lemmings (*Dicrostonyx groenlandicus*) were present in the area but were not abundant. Hares (*Lepus arcticus*) were seen within 200 yards of the nest and seemed not to be disturbed by the screams of the hawks.

I wish to acknowledge the assistance of the Arctic Section of the U.S. Weather Bureau, whose cooperation made possible the studies here reported.—CHARLES O. HANDLEY, JR., *U.S. National Museum, Washington 25, D.C., December 15, 1955.*

Purple Finch nesting at Toledo, Ohio.—On June 19, 1955, Mayfield watched a female Purple Finch (*Carpodacus purpureus*) carrying nesting material into a cluster of twigs near the top of a blue spruce in Ottawa Park, Toledo, Ohio. On July 7, McCormick erected an extension ladder with guy wires at this point, and at about 7:00 a.m. found a nest containing two eggs and three young that appeared to have been hatched the same morning.

The nest was supported in a horizontal fork 31 feet from the ground, 8 feet south of the center of the tree, and 1½ feet from the tip of the bough. A third branch from the same fork lay closely over the nest, concealing it except for a small opening directed almost horizontally outward. The nest was built of small twigs and lined with grasses. A rosy-plumaged male sang frequently from the nest tree during the building activities and on several occasions chased a brown-plumaged male that sang nearby. At least two males had been singing in this area when they were noticed by Mayfield several days earlier.

There are several interesting circumstances about this nest: (1) We believe it to be the first nesting of the Purple Finch in northwestern Ohio, the few other nesting records for the state coming from the northeastern portion, where there are remnants of original pine and hemlock. (2) The birds nested among planted spruce in an area where there are no original conifers. The only nesting locations reported for Michigan south of the conifer belt have also been among planted evergreens at Ann Arbor and Bloomfield Hills. (3) The nest was completely invisible from below and was not discovered until McCormick parted the branches above it. (4) The birds seemed little disturbed by human activity nearby. The nest tree was located in one of the busiest portions of the Park, at the edge of a baseball diamond used every day and less than 50 feet from a main road through the Park. The female dodged between passing cars as she carried nesting material.—Harold F. Mayfield, *2557 Portsmouth Ave., and* John M. McCormick, *1827 Richards Road, Toledo, Ohio, December 28, 1955.*

Winter foods of Evening and Pine Grosbeaks in West Virginia.—During the past few winters Evening and Pine Grosbeaks have been recorded in unprecedented numbers in West Virginia. Evening Grosbeaks (*Hesperiphona vespertina*) were abundant and wide-spread during the winters of 1952–53, 1954–55, and 1955–56. Pine Grosbeaks (*Pinicola enucleator*), rarely recorded in any previous years, were common in mountainous sections during 1954–55, and have returned in some numbers in 1955–56. These visitations have afforded many opportunities for observing food habits of the two species in a region which has been thought of as south of their customary winter ranges.

During all their visits Evening Grosbeaks have, in snowy times in particular, habitually fed on cinders and other gritty material scattered on public highways to prevent car-skidding. They have shown special preference for cinders which have been treated with some salt. On December 22, 1954, five flocks numbering over 200 birds were seen in a ten-mile stretch of state route 32, in Tucker County, West Virginia. Since the birds were slow in flying from approaching cars, many of them were killed, and Wayne Bailey, C. O. Handley and others had the chance to examine numbers of specimens.

From the specimens whose digestive tracts were examined, and through field observations, it became evident that Evening Grosbeaks were eating a much wider variety of foods than might have been expected from their recorded feeding habits northward. The year 1954 saw a remarkably heavy crop of beechnuts (*Fagus grandifolia*) in this region, and birds examined by Bailey and Handley had their crops stuffed with these

nuts. Near Morgantown, the home of Richard F. Sowers has a large beech tree on the lawn. Evening Grosbeaks in flocks up to 50 birds searched the grass for these nuts, remaining until May 12, 1955.

On a number of occasions in 1952, Marion L. Hundley and the writer watched Evening Grosbeaks cutting through the hulls of and feeding on the nuts of scarlet oak (*Quercus coccinea*). The birds used their bills to slice open acorns which had fallen to the ground. We examined a number of the partially-eaten nuts.

Another much-eaten food was the winged seeds of tulip poplar (*Liriodendron tulipifera*). Since this tree does not grow very far northward, the birds are obviously adapting their eating habits to new foodstuffs when they move south. Other winged seeds, particularly those of box elder (*Acer negundo*) and white ash (*Fraxinus americana*) were, as might be expected, commonly eaten. Buds of trees, especially of large-toothed aspen (*Populus grandidentata*), birches (*Betula* sp.), and maples (*Acer* sp.) were frequently fed upon.

Not until the winter of 1954-55 did observers in West Virginia have many opportunities to observe food habits of Pine Grosbeaks. In November of that year, however, the birds were widely distributed and locally common in mountainous areas. They remained until February, affording bird students many chances to make field observations.

The birds fed on frozen fruits (particularly apples), seeds of maple and white ash, and on some portion of the twigs of conifers, especially pitch pine (*Pinus rigida*). In addition they made extensive use of other plant foods, some of which would not be available northward. These included seeds of tulip poplar, wild grapes (*Vitis* sp.), black haw and wild raisin (*Viburnum prunifolium* and *V. cassinoides*), flowering dogwood (*Cornus florida*), and greenbrier (*Smilax* sp.). Bailey, James Beach, and others found the birds feeding on fruits of staghorn sumach (*Rhus hirta*).

Local observers are hoping that the wider range of acceptable foodstuffs southward may influence future winter movements of these two bird species.—MAURICE BROOKS, *Division of Forestry, West Virginia University, Morgantown, West Virginia, January 10, 1956.*

A Lincoln Sparrow on the east coast of Florida.—In the course of trapping small mammals at Ormond Beach, Volusia County, Florida, December 26-28, 1954, I caught by fortunate accident a specimen of the Lincoln Sparrow (*Melospiza lincolnii*). The bird, a male, was dead but in good condition when found about 8:00 a.m. on the 27th; it was made into a study skin (R.A.N. 1501) and has been deposited in the collection of the Biology Department at the University of Georgia. The vegetation of the trapping site, which was in a residential area, included grasses, sere composites, a clump of yellow jessamine, camphor trees, and a patch of scrub palmetto. There was no water or marshy vegetation close by; the nearest salt marsh was a quarter mile away, the ocean a half mile away.

As compiled by Sprunt (1954. "Florida Bird Life," pp. 491, 492), previous records of the Lincoln Sparrow in Florida are as follows: Orlando, January 23, 1911, one seen (H. W. Ballantine); Lake Iamonia, March 26, 1919, one seen (L. Griscom); Whitney Plantation, Leon County, March 13, 1925, one collected (H. L. Stoddard); and near Pensacola, December 28, 1952 (and again some days later), one seen (F. M. Weston). As reported by Stevenson (1955. *Audubon Field Notes*, 9(1):22), one of these sparrows was collected by H. L. Stoddard on Alligator Point, Franklin County, October 15, 1954, the first autumnal record for the state. Still more recently, Mr. Stoddard (written communication) established another fall record when he picked up a bird, too much

damaged for preparation as a skin, under the television tower on Tall Timber Plantation, northern Leon County, on October 9, 1955.

Although my December bird is by no means a "first" for Florida, it seems nonetheless the first Lincoln Sparrow to be recorded for the Atlantic coastal strip of the southeastern United States.—ROBERT A. NORRIS *(University of Georgia Ecological Studies, AEC Savannah River Plant area), 535 Powderhouse Road, Aiken, South Carolina, January 31, 1956.*

Breeding record of Brewer Sparrow in northwestern Montana.—The Brewer Sparrow (*Spizella breweri breweri*) breeds in Montana east of the continental divide (Saunders, 1921. *Pacific Coast Avif.*, No. 14) and in eastern Washington (Wing, 1950. *Auk*, 66:41). This sparrow, however, has not been recorded from the northwestern mountainous region of Montana.

In the summer of 1955, in the course of work carried on at the Flathead Lake Biological Station of the Montana State University, a small breeding population of the Brewer Sparrow was found in sagebrush habitat at 3,000 feet elevation in the valley of the Little Bitterroot River in Sanders County, Montana. This is about midway between the populations of Washington and eastern Montana. Six specimens were collected 5 miles south of Niarada, July 16 to 22. Two of the birds were adult males with testes in breeding condition (7 and 8 mm.). Two were adult females (ova 1.5 and 1.0 mm.), each with a naked brood patch. The other two were juveniles, one still in postnatal molt with rectrices unsheathing (July 16), the other with postnatal molt completed (July 17). It is likely that these juveniles were recently out of the nest and were produced near the locality where they were collected.

The Brewer Sparrows were found mainly on low hillocks and in swales supporting a sagebrush vegetation in which two types of wormwood, *Artemisia ludovicianus* and *A. dracunculus*, occurred and also two species of rabbit brush, *Chrysothamnus viscidiflorus* and *C. nauseosus*. The shrubs were typically one to three feet high. Also snowberry (*Symphoricarpos* sp.) and hawthorn (*Crataegus* sp.) were scattered about, and in a few moister places service-berry (*Amelanchier* sp.), rose (*Rosa* sp.), and willow (*Salix* sp.) occurred. The life zone is Upper Sonoran. Sagebrush habitat is quite limited in northwestern Montana, and this may be why the Brewer Sparrow has been overlooked here.

Associated with the Brewer Sparrow in the dry sagebrush habitat were Vesper Sparrows (*Pooecetes gramineus*), Horned Larks (*Eremophila alpestris*), and Sharp-tailed Grouse (*Pedioecetes phasianellus*), while a greater variety of species was present at interspersed moist or marshy spots, including the Song Sparrow (*Melospiza melodia*), Traill Flycatcher (*Empidonax traillii*), and the Eastern Kingbird (*Tyrannus tyrannus*). —PAUL H. BALDWIN, *Department of Zoology, Colorado A. and M. College, Fort Collins, Colorado, and Montana State University Biological Station, Bigfork, Montana, February 17, 1956.*

Unusual eggs of the Boat-billed Heron.—The eggs of the Boat-billed Heron (*Cochlearius cochlearius*) have seldom been described, although the species occupies much of the Neotropical lowlands and is fairly common locally. Belcher and Smooker (1934. *Ibis*, p. 583), apparently the first to publish detailed information, described the eggs as "pale bluish-white, the larger pole being usually faintly spotted or splashed with red. Four average 48.5 × 35.5 mm." Two eggs are considered to comprise a clutch. In Trinidad breeding has been noted in July and August.

Hellebreker's study (1945. *Zool. Meded. Leiden*, 24:243) of 574 (!) *Cochlearius* eggs in the Penard Collection is substantially in agreement with the observations of Belcher and Smooker. The color is described as bluish when fresh, fading to dirty white with age, and very slightly spotted at the large end. Hellebreker reports no unmarked eggs, nor any with "splashes" of color. Measurements (in mm.) of 50 eggs were: average, 50.25 × 35.25; minimum, 44.9 × 33.9, 49.1 × 33.2; maximum, 57.1 × 36.6, 49.4 × 38.9. The breeding season in Dutch Guiana is June and July.

Through the courtesy of Mr. Karl Plath the Chicago Natural History Museum recently acquired four eggs of this heron laid in the Brookfield Zoo by a captive bird that is believed to represent the nominate race. These eggs are unusual in several respects. All four, and two additional eggs (retained by the zoo) laid by the same bird, are pale bluish-white, without the slightest evidence of spotting or other marking. The six eggs were laid from December 20 to January 15, inclusive, as compared with the June–August breeding records of wild birds. Partial verification of the Belcher and Smooker inference that two eggs comprise a clutch is suggested by the paired spacing of the first eggs (December 20, 23; January 5, 9, 12, 15). Measurements of four eggs: 46.3 × 36.3 mm.; 46.0 × 35.8; 44.4 × 35.7; 45.2 × 36.2.—EMMET R. BLAKE, *Chicago Natural History Museum, Chicago 5, Illinois, January 30, 1956.*

The aftershaft in jacamars and puff-birds.—The presence of an aftershaft in the Jacamars (Galbulidae) and its alleged absence in the closely-related Puff-birds (Bucconidae) has long been used as an important character separating these two piciform families. The supposed absence of the structure in puff-birds apparently originated with the statement by Nitzsch (1840:94–95) who examined the species known today (Peters, 1948) as *Bucco tamatia, B. capensis, Nystalus chacuru* and *Malacoptila fusca*. Forbes' diagnosis of the family in the monograph by Sclater (1882) also indicated the aftershaft as absent. In subsequent publications Sclater (1891; 1909) used the same diagnosis. Ridgway (1914:371), apparently following Sclater, used "contour feathers without aftershafts" as a character separating the puff-birds from the jacamars. Beddard (1898:189) recorded that in the puff-bird *Malacoptila fusca* "the aftershaft is absent." Beddard's statement is probably the source of Stresemann's (1927–1934:839) notation that *Malacoptila* is without an aftershaft. Stresemann's statement is so worded as to imply that this is the only genus of jacamars and puff-birds entirely lacking an aftershaft.

In an attempt to resolve the seemingly differing opinions as to the occurrence of the aftershaft in the Bucconidae, ventral contour feathers from several species of puff-birds have been examined. Several members of the Galbulidae have been studied for comparison.

In all of the jacamars examined the aftershaft is present and originates as a single shaft from the proximal margin of the superior umbilicus. This single shaft subdivides to form a tuft of approximately 15 (12 to 17 counted) barbs. The barbules lack hamuli and this downy tuft constitutes the vane of the aftershaft. The junction of the hyporhachis with the rhachis of the main feather is discrete and well separated from the proximal barbs of the vane of the main feather.

In the puff-birds the condition of the aftershaft is somewhat different. Instead of arising from a single shaft there is a group of barbs, each arising separately from the proximal margin of the superior umbilicus. That these barbs are homologous to the well-formed aftershaft of the jacamars is indicated by their position, their number (approximately 12) and their direction, namely, parallel to the rhachis of the main feather, not lateral to it as with the barbs of the vane. There is not, however, a

sharp break between the lateral barbs and those forming the aftershaft group. The most proximal lateral barbs originate progressively toward the ventral midline of the feather and thus gradually come into alignment with the aftershaft group. It may have been this situation which led Forbes to the conclusion that no aftershaft was present. A point of difference between the aftershaft barbs and the lateral vane barbs lies in the structure of the axis or shafts of these barbs. The shafts of the aftershaft group are fine, round filaments; those of the lateral barbs are relatively broad and flat.

Additional evidence that this group of barbs is homologous to a true aftershaft is found in the studies of Lillie and Juhn (1937) on the origin of the aftershaft. Their observations indicate that barbs arising in the center of the "ventral triangle," and having a vertical arrangement, are properly considered homologous with the aftershaft.

If, in view of this evidence, the aftershaft in the Galbulidae is regarded as homologous to the group of barbs described above in the Bucconidae, the latter group should be diagnosed as possessing an aftershaft. The marked and consistent differences in aftershaft structure however, still provide a mutually exclusive pair of diagnostic family characters.

The species examined were as follows: Galbulidae: *Galbalcyrhynchus leucotis, Brachygalba lugubris, Jacamaralcyon tridactyla, Galbula albirostris, Galbula galbula, Galbula tombacea, Galbula ruficauda, Galbula leucogastra, Galbula dea* and *Jacamerops aurea.* Bucconidae: *Notharcus macrorhynchos, Notharcus pectoralis, Notharcus tectus, Bucco macrodactylus, Bucco tamatia, Bucco capensis, Hypnelus ruficollis, Malacoptila striata, Malacoptila panamensis, Malacoptila mystacalis, Monasa atra* and *Chelidoptera tenebrosa.*

All specimens were examined with a 20× binocular microscope.

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Charles G. Sibley, *Department of Conservation, Cornell University, Ithaca, New York, March 6, 1956.*

PROCEEDINGS OF THE THIRTY-SEVENTH ANNUAL MEETING

BY PHILLIPS B. STREET

The Thirty-seventh Annual Meeting of the Wilson Ornithological Society was held at Buffalo, New York, from Thursday, April 26, to Sunday, April 29, 1956. It was sponsored by the Buffalo Audubon Society, the Buffalo Ornithological Society and the Buffalo Society of Natural Sciences.

There were four sessions devoted to papers and two business meetings at the Buffalo Museum of Science. Motion pictures by members of the Local Committee were shown at the Museum on Thursday evening, and the Executive Council met at the Hotel Statler at the same time. The Annual Dinner was held at the Statler on Saturday evening, President Burt L. Monroe delivering the President's Address and Dr. Finn Salomonsen, Zoological Museum, University of Copenhagen, speaking on "The Birds of Greenland," with slides and motion pictures.

Early morning field trips were taken to the shore of Lake Erie, southwest of Buffalo, and to Grand Island in the Niagara River. The Sunday field trip included the Oak Orchard Swamp Wildlife Refuge and the Lake Ontario shore west of Rochester.

First Business Session

President Monroe called the meeting to order at 10:00 a.m., Friday, April 27. Welcomes were given by Mr. George F. Goodyear, President of the Buffalo Society of Natural Sciences, Miss Gertrude Webster, President of the Buffalo Audubon Society, and Mrs. Alice Ulrich, President of the Buffalo Ornithological Society. President Monroe responded. The minutes of the 36th Annual Meeting were approved as published in *The Wilson Bulletin* for September, 1955.

Secretary's Report

The secretary, Phillips B. Street, summarized the principal actions taken at the previous evening's Executive Council meeting as follows:

1. Council accepted invitations from (1) the Minnesota Ornithologists Union, the University of Minnesota, Duluth Branch, and the Duluth Bird Club to meet at Duluth from June 13–16, 1957, (2) the Brooks Bird Club to meet at Oglebay Park, Wheeling, West Virginia, April 24–27, 1958, and (3) the Kentucky Ornithological Society to meet at Kentucky Dam (tentative) in late April, 1959.
2. Keith L. Dixon was reelected editor of *The Wilson Bulletin*.

Treasurer's Report

The treasurer, Ralph M. Edeburn, submitted the following report on the finances of the Society:

Report of Treasurer for 1955

Balance as shown by last report, dated December 31, 1954		$ 3,913.14
General Fund		
Receipts		
Dues:		
Active	$ 3,531.00	
Sustaining	1,475.00	$ 5,006.00
Subscriptions to *The Wilson Bulletin*		522.00
Sale of back issues & reprints of *The Wilson Bulletin*		257.45
Gifts:		
Library Book Fund	$ 26.00	

Miscellaneous	41.70	67.70	
Payments for Foreign Postage		4.40	
Refund from Registration, Stillwater Meeting		96.93	
Miscellaneous Income		10.22	5.964.70
Total Receipts			$ 9,877.84

DISBURSEMENTS

The Wilson Bulletin—printing and engraving	$ 4,009.47	
The Wilson Bulletin—mailing and maintenance of mailing list	823.18	
Editor's Expense—clerical	100.00	
Treasurer's Expense—printing, postage, etc.	250.81	
Secretary's Expense—printing, and postage for annual meeting	334.84	
Committee Expense—printing and postage	62.16	
Purchase of books from Book Fund for Library	22.75	
Purchase of back issues and reprints	10.54	
Miscellaneous—other officers	68.86	
Total Disbursements		$ 5,682.61
Balance on hand in Twentieth Street Bank, Huntington, West Virginia, December 31, 1955		$ 4,195.23

ENDOWMENT FUND

Balance in Savings Account as shown by last report, dated December 31, 1954			$ 454.34
Receipts			
Interest on Investments, Savings and Dividends	$ 293.12		
Sale of U.S. Postal Savings Coupon Bonds (matured)	780.00		
Life Membership payments	750.00	$ 1,823.12	
Total Receipts			$ 2,277.46
Disbursements			
Louis Agassiz Fuertes Research Grant	$ 100.00		
Purchase 20 shares Firemans Fund Insurance	1,335.00		
Total Disbursements			$ 1,435.00
Balance in Savings Account, Twentieth Street Bank, Huntington, West Virginia, December 31, 1955			$ 842.46
*Securities Owned**			
U.S. Savings Bonds, Series "G," dated September 1, 1943 (maturity value $1,000.00)	$ 1,000.00		
U.S. Savings Bonds, Series "G," dated December 20, 1944 (maturity value $1,500.00)	1,479.00		
U.S. Savings Bonds, Series "G," dated June 1, 1945 (maturity value $500.00)	489.50		
U.S. Savings Bonds, Series "G," dated July 1, 1945 (maturity value $900.00)	881.10		
U.S. Savings Bonds, Series "G," dated October 1, 1945 (maturity value $1,400.00)	1,370.60		
U.S. Savings Bonds, Series "F," dated February 1, 1947 (maturity value $2,000.00)	1,774.00		
U.S. Savings Bonds, Series "F," dated April 1, 1948 (maturity value $2,000.00)	1,722.00		
U.S. Savings Bonds, Series "F," dated October 1, 1948 (maturity value $1,450.00)	1,210.94		

U.S. Savings Bonds, Series "F," dated April 1, 1950 (maturity value $1,000.00)	809.00	
Total Value of Government Bonds	$10,736.14	
Massachusetts Investors Trust (123 shares at $32.84)	4,039.32	
Firemans Fund Insurance (50 shares at $66.00)	3,300.00	
Total Securities Owned		$18,075.46
Total in Endowment Fund,** December 31, 1955		18,917.92

*Bonds carried at redeemable value December 31, 1955 and stocks carried at closing prices December 31, 1955.

**_In Reserve:_

Louis Agassiz Fuertes Research Fund (special gifts)	$ 325.00
S. Morris Pell Fund (special gift)	75.00

Respectfully submitted,
/s/RALPH M. EDEBURN,
Treasurer.

Research Grant Committee

Kenneth C. Parkes, chairman, reported that five applications for the Louis Agassiz Fuertes Research Grant were received, with two being outstanding, resulting in an exact tie vote. The Committee had recommended that Council either (1) award duplicate grants of $100, (2) award a split grant of $50 each, or (3) choose between the two and give a single award. Council voted to make an exception to the general rule and awarded duplicate $100 grants to John Burton Millar, University of Wisconsin, whose study is "An investigation of possible factors involved in the initiation of migration," and Lester L. Short, Jr., Cornell University, who is studying "Hybridization and isolating mechanisms in North American Flickers (*Colaptes*)."

An S. Morris Pell award for the encouragement of bird art of $25 was voted to Donald R. Altemus, State College, Pennsylvania.

Membership Committee

John M. Jubon, chairman, reported by letter that the names of 169 prospective new members enrolled since the 1955 meeting were posted for the inspection of members and to be elected at the final business meeting. On December 31, 1955, the Society had 106 life, 297 sustaining and 1216 active members, a total of 1619. 13 new life members have been added since January 1, 1955. There were 163 institutional subscriptions to *The Wilson Bulletin.*

Library Committee

H. Lewis Batts, chairman, reported by letter. During the past twelve months the Society has received gifts to the Library of 66 books, 214 reprints, 140 magazines, 33 bulletins, 22 pamphlets and one phonograph record. Ten additional books have been purchased by funds given by members. In all, 72 persons and 3 institutions have made gifts to the Society Library. In addition, the Library has received serial publications on birds from all over the world in exchange for *The Wilson Bulletin.* These exchanges now total 80 titles; 20 other serials are received as gifts.

The University of Michigan has done its part by keeping the accessions catalogued and the completed serial volumes bound up to date. It has also supplied the manpower and outbound postage for sending out loans to all members who have requested items. The University Museum of Zoology staff has also many times volunteered

bibliographic research help to Society members who needed help. The University has continued to receive and store back stock of *The Wilson Bulletin* and to send out numbers, volumes, and sets on order from the Treasurer.

The annual list of books added to the Library was not published last September but will be published this year. At that time we also hope to publish a list of the serial holdings.

There have been many generous gifts, but the outstanding donor is Capt. Karl Haller of the U.S. Air Force, a member of the Society for 22 years. His gifts, 28 books since the last publication of the Society holdings, included such important and costly items as Peters "Check-list of Birds of the World" (7 vols.); Ridgway and Friedmann, "Birds of North and Middle America" (11 vols.); Bannerman's "Birds of the British Isles" (4 vols.); and Cory and Hellmayr, "Catalogue of Birds of the Americas" (19 vols.).

Conservation Committee

Robert A. Pierce, chairman, reported by letter. During 1955, three articles were prepared by the Conservation Committee for publication in *The Wilson Bulletin*. Two of these have been published; one on Poisons and Wildlife will appear shortly. A request was received from the British Waterfowl Trust for permission to reprint the article on waterfowl conservation by Frank Bellrose, Jr. and Thomas G. Scott. The writer wishes to express his sincere appreciation for the splendid cooperation which he received from each member of the Committee which, aside from your chairman, was composed of P. F. English, Lee E. Yeager, Thomas G. Scott and Frank Bellrose, Jr.

As most of the Society members know, there are a number of pressing current conservation problems. One of the most important at the moment is the invasion of wildlife refuges and National Forests by the armed forces and by commercial interests. One of the latest moves in this respect is the introduction of two bills, S. 3360 and H.R. 9965, by which the U.S. Army seeks Congressional approval for the transfer of 10,700 acres of the Wichita Mountains National Wildlife Refuge in Oklahoma for enlargement of Fort Sill. Previous attempts by the Army to secure this land have failed and the writer would like to point out that undoubtedly the vigorous individual efforts of some of the members of this organization were an important factor in encouraging Secretary McKay to refuse the Army's request for transfer of this land to Fort Sill. Your efforts must continue, however.

The Armed Services are attempting to take over all or parts of various other refuges, National Forest areas or Park areas. The plan to extend the photoflash bombing area to the edge of the Aransas National Wildlife Refuge in Texas with its unpredictable effects upon the Whooping Cranes is familiar to all. Public opposition appears to have stopped this latter project, although it is well to remember that the projects of some agencies never seem to die but only go into hiding for a time. The policy of making oil and gas leases on National Refuges does not appear to be a management technique which can enhance the value of these areas very greatly for wildlife but the writer does not know the present status of this policy.

Some good things have happened for conservation during 1955. Revision of the old mining law makes it possible to eliminate most fraudulent or invalid mining claims. A method of distributing the $13,500,000 surplus Federal Aid to Wildlife Restoration funds was authorized by Congress and the uses that can be made of the money were broadened somewhat. According to information reaching the writer, a revised plan of State and Federal cooperation may be proposed which will require the gathering of more adequate ecological data to support administrative decisions regarding introduc-

tions of exotic and native animals. This plan, if accepted and followed by the States, cannot help but improve this program. The plan cannot prevent the individual States from continuing their own programs, however, and this fact should serve to remind us that much conservation work is done at the State and local levels and that each of us can perform a service for conservation in our own States and localities.

Congressional action on various bills of importance to conservation has been influenced by the activities of various conservation groups and individuals. The writer wishes again to stress the importance of each individual's personal efforts in bringing matters of conservation importance to the attention of lawmakers and conservation officials.

Endowment Committee

In the absence of Robert T. Gammell, chairman, Leonard C. Brecher spoke briefly on the value of life memberships, stressing the fact that a life membership taken out in four installments during one's years of high earning power may be doubly appreciated upon retirement. He read the names of life members enrolled since January 1, 1955.

Temporary Committees

The President appointed the following temporary committees:

Auditing Committee
N. Bayard Green, Chairman
Lois Garrett
Hugh Land

Resolutions Committee
Mrs. Betty Carnes, Chairman
Maurice Graham Brooks
Pershing B. Hofslund

Nominating Committee
Aaron M. Bagg, Chairman
Karl H. Maslowski
A. W. Schorger

SECOND BUSINESS SESSION

The final business session was called to order at 10:00 a.m., Saturday, April 28.

The applicants for membership, whose names were posted, were elected to membership.

Report of the Auditing Committee

The committee reported by letter that they had examined the books and accounts of the treasurer and found them to be in good order.

Report of the Resolutions Committee

BE IT RESOLVED that the Wilson Ornithological Society express its deep appreciation to the Buffalo Audubon Society, the Buffalo Ornithological Society and the Buffalo Society of Natural Sciences for their warm hospitality at this, our Thirty-seventh, Annual Meeting. Most especially we wish to thank Fred T. Hall and the hard-working members of the Local Committee for their most efficient handling of the many time-consuming details of this meeting.

The projection of our slides and films by Charles Simmons has been especially notable.

We have enjoyed the stimulating exhibits and well planned facilities of the Museum of Science. We are most grateful to the Museum staff and the Local Committee for making our Buffalo stay so pleasant and profitable.

BE IT FURTHER RESOLVED that the members of the Wilson Ornithological Society

be urged in this critical time for conservation interests to express their opinions and desires to the appropriate legislative and administrative bodies.

Election of Officers

The Nominating Committee proposed the following officers for the coming year: President, John T. Emlen; First Vice-President, Lawrence H. Walkinshaw; Second Vice-President, Phillips B. Street; Secretary, Fred T. Hall; Treasurer, Ralph M. Edeburn; Elective members of the Executive Council, Harvey I. Fisher (term expires 1957), Leonard C. Brecher (term expires 1958), and Andrew J. Berger (term expires 1959).

The report of the committee being accepted, and there being no nominations from the floor, the secretary was instructed to cast a unanimous ballot for these nominees.

PAPERS SESSIONS

Friday, April 27

Harold D. Mitchell, Buffalo, New York, *Ornithological Introduction to the Niagara Frontier*, slides.

Clark S. Beardslee, Kenmore, New York, *Birds' Migration Routes in the Niagara Frontier Area*, slides.

Frederick M. Helleiner, Toronto, Ontario, *Bird Observations on a Trans-Atlantic Crossing*.

Finn Salomonsen, Zoological Museum, University of Copenhagen, *The Greenland Bird Banding System*, slides.

James Baird, Norman Bird Sanctuary, Newport, Rhode Island, *Yellow-throated Warbler Breeding in Sycamores and Collected Along the Delaware River in New Jersey* (read by title).

Donald J. Borror and Carl R. Reese, Department of Zoology and Entomology, Ohio State University, *Vocal Gymnastics in Wood Thrush Songs* (presented on tape), slides.

William W. H. Gunn, Federation of Ontario Naturalists, Toronto, Ontario, *Some Warbler Songs on Tape*, tape.

Dean Amadon, American Museum of Natural History, *Some Problems in Preparing an Exhibit of Local Birds*, slides.

Josselyn Van Tyne, University of Michigan Museum of Zoology, *The Discovery of the Evening Grosbeak*, slides.

Elsa G. Allen, Laboratory of Ornithology, Cornell University, *Some Manuscript Sources in Early American Ornithology*, slides.

James Hartshorne, Laboratory of Ornithology, Cornell University, *The Voice of the Trumpeter Swan*, tape and slides.

Arthur A. Allen, Laboratory of Ornithology, Cornell University, *The Voice of the Whooping Crane*, tape and motion pictures.

Saturday, April 28

Robert L. Smith, Department of Conservation, Cornell University, *Some Factors Influencing the Colonization of Coniferous Plantations by Birds*, slides.

David A. West, Department of Conservation, Cornell University, *Problems in the Appraisal of Hybrid* Pheucticus *Grosbeaks*, slides.

Lester L. Short, Jr., Department of Conservation, Cornell University, *Hybridization Between Gilded and Red-shafted Flickers*, slides.

Charles G. Sibley, Department of Conservation, Cornell University, *Hybridization and Sexual Selection as Factors in the Evolution of Birds*, slides.

Oliver H. Hewitt, Department of Conservation, Cornell University, *Studies of the Newfoundland Willow Ptarmigan*, tape and slides.

Gerald R. Rising, Rochester, New York, *The New York State Waterfowl Census.*

Robert D. Burns, Michigan State University, Department of Zoology, *Movements of the Cardinal*, slides.

Maurice Graham Brooks, West Virginia University, *Diurnal Migration Along Certain Appalachian Ridges.*

Kenneth C. Parkes, Carnegie Museum, *Winter Survival of an Escaped Audubon's Caracara.*

Lawrence I. Grinnell, Ithaca, New York, *African Birdlife from Cape to Equator*, motion pictures.

Edward M. Brigham, Jr., Kingman Museum of Natural History, Battle Creek, Michigan, *Some Birds of Woody Island, Lake Bowdoin National Wildlife Refuge, Montana*, motion pictures.

Crawford H. Greenewalt, Wilmington, Delaware, *Slow-Motion Pictures of the Ruby-throated Hummingbird in Flight* (read by title), motion pictures.

Attendance

Members and guests who registered totalled 145. Eleven states, the Province of Ontario, Argentina and Denmark were represented.

From **Indiana:** 2—*Indianapolis*, Mildred Campbell, Mrs. S. G. Campbell.

From **Kentucky:** 4—*Anchorage*, Mr. and Mrs. Burt L. Monroe; *Louisville*, Mr. and Mrs. Leonard C. Brecher.

From **Massachusetts:** 3—*Amherst*, Jerry Brown; *Dover*, Mr. and Mrs. Aaron M. Bagg.

From **Michigan:** 11—*Alma*, Lester E. Eyer; *Ann Arbor*, Mr. and Mrs. Ralph Branch, Peter Stettenheim, Josselyn Van Tyne; *Battle Creek*, Mr. and Mrs. Edward M. Brigham, Jr., Lawrence H. Walkinshaw; *Jackson*, Robert A. Whiting; *Lansing*, Robert D. Burns; *Mt. Pleasant*, Nicholas L. Cuthbert.

From **Minnesota:** 1—*Duluth*, Pershing B. Hofslund.

From **New Jersey:** 1—*Tenafly*, Betty Carnes.

From **New York:** 78—*Albany*, Ralph S. Palmer, Mrs. Dayton Stoner; *Alleghany*, Stephen W. Eaton; *Armonk*, Kenneth D. Morrison; *Buffalo*, Agnes C. Abrams, Mr. and Mrs. Harold H. Axtell, Sylvia Booth Brockner, John H. Caul, Mr. and Mrs. Edward R. Cummiskey, Richard Drobits, Mary Louise Emerson, Rose W. Facklam, John S. Filor, Mrs. Hans H. Gros, Fred T. Hall, Bernard Hochmuth, Ellsworth Jaeger, Ralph Kaz, Mercedith Lovelace, Mrs. Lloyd Mansfield, Harold D. Mitchell, Bernard Nathan, Donald J. Powers, Eugenia Praemassing, Kathryn Praemassing, Mr. and Mrs. Malcolm M. Renfrew, Frances M. Rew, Edith M. Robson, James Savage, Albert R. Shadle, Charles E. Simmons, Mrs. Howard C. Smith, William R. Taber, Mrs. Margaret M. Teare, Heather G. Thorpe, Lena Turner, Mr. and Mrs. Edward C. Ulrich, Mrs. Elsie E. Webb; *Delmar*, Victor H. Calhane; *East Aurora*, R. D. Coggeshall; *Fredonia*, Willard F. Stanley; *Hamburg*, Mrs. John E. Bacon, Mrs. LeRoy Melberg; *Ithaca*, Hermon P. Adam, Mr. and Mrs. Arthur A. Allen, Millicent S. Fecken, Richard B. Fischer, Lawrence I. Grinnell, James M. Hartshorne, Mrs. Southgate Y. Hoyt, Edward L. Seeber, Lester L. Short, Jr., Charles G. Sibley, Robert L. Smith, David A. West, Maurice J. Zardus, Jr.; *Kenmore*, Clark S. Beardslee, Alice S. Dietrich, Philip S. Greene, Frances Rathbun, Gertrude G. Webster; *Manhasset*, Mary Anne Heimerdinger; *New York*, Dean Amadon, Mrs. C. N. Edge, Eugene Eisenmann; *Orchard Park*, Robert F. Andrle; *Rochester*, H. Everest Clements, Reginald N. Hartwell, Mr. and Mrs. Gerald R. Rising; *Waterloo*, Jason A. Walker; *Watertown*, Harold W. Hill; *Williamsville*, Marie A. Wendling.

From **Ohio:** 16—*Cleveland*, Mr. and Mrs. H. C. Dobbins, Adela Gaede, Warner Seely, Mildred Stewart; *East Cleveland*, Vera Carrothers; *Painesville*, Mrs. Robert V. D. Booth; *Poland*, Mr. and Mrs. Evan C. Dressel; *Steubenville*, Mr. and Mrs. Clinton S. Banks, Earl W. Farmer; *Toledo*, John M. McCormick, Mr. and Mrs. Albert R. Tenney, Robert H. Turner.

From **Pennsylvania:** 9—*Allport*, Elsie C. Erickson; *Butler*, Mr. and Mrs. Frank W. Preston; *Chester Springs*, Mr. and Mrs. Phillips B. Street; *Kane*, Sybil K. Kane; *Mt. Jewett*, Mrs. Florence Kane Johnson; *Pittsburgh*, Kenneth C. Parkes, George B. Thorp.

From **West Virginia:** 2—*Huntington*, Ralph M. Edeburn; *Morgantown*, Maurice G. Brooks.

From **Wisconsin:** 1—*Madison*, John T. Emlen.

From **Ontario, Canada:** 14—*Fort William*, A. E. Allin; *Guelph*, Alex T. Cringan, H. G. Mack, A. de Vos; *Hamilton*, Eric W. Bastin, R. G. C. MacLaren, George W. North; *Pickering*, Mr. and Mrs. J. Murray Speirs; *Toronto*, J. Bruce Falls, Mr. and Mrs. William W. H. Gunn, Frederick M. Helleiner, Mrs. Osborne Mitchell.

From **Argentina:** 1—*Buenos Aires*, William H. Partridge.

From **Denmark:** 1—*Copenhagen*, Finn Salomonsen.

POISONS AND WILDLIFE

A Contribution from the Wilson Ornithological Society Conservation Committee

The empirical title of this article is an admission of the broadest possible consideration, here, of the relationships of animal-control poisons to wildlife generally. Indeed, this discussion cannot be a coverage, however broad, of a subject handled only inadequately in many papers and texts; rather, it is an attempt to sketch the amazing scope and application of poisons used in control, and to contemplate their mass impact on mammals, birds, fish and other life esteemed by man.

In this attempt, the commentator wishes to be objective. Poisons, with affinities for both production and destruction of valuable crops, are obviously two-sided in significance; no discussion, even in a medium dedicated to resource appreciation and management, should overlook poison's role in the provision of man's food and fiber, to say nothing of his health and well-being. This, then, is neither approval nor denunciation of poisons *per se*; it is a plea for facts based on objective and controlled research; and moderation in the use of new, highly toxic poisons until such information is available.

Some agricultural remedies involving poisons are now so widely accepted that they are taken as a matter of course. The use of lead arsenate in potato-bug control is illustrative, though but one of scores of examples. Thousands of poison compounds—organic and inorganic, natural and synthetic—are known, but probably not over 100 are actually employed in insecticides. Others are being introduced at a rapid rate.

Herbicides, or plant-killing compounds, are newer, but they have a manifest potential in the field of plant control as great as insecticides and related poisons in animal control. Even less is known of their ultimate effects on birds and mammals than those of the older, longer-used animal-control poisons. Many of these effects are from the standpoint of cover, which also represents, directly or indirectly, an important source of wildlife food supply.

It is unfortunate, indeed, that insecticides and herbicides collectively—so dramatically

successful for the specific purposes for which they were developed—constitute a serious threat to exceedingly valuable wild-animal life.

It would seem that the greatest threat to wildlife inherent in insecticidal and herbicidal poisons lies in their prodigiously increasing use, particularly in cases where their effects on wildlife have not been adequately determined. Some idea of the tremendous volume of poisons used is indicated by the following figures:

In the United States, largely in the control of cotton insects, 20,000,000 pounds of calcium arsenate and 30,000,000 pounds of lead arsenate are used annually.

In the United States, in 1952, about 85,000,000 pounds of DDT and 92,000,000 pounds of benzene hexachloride (BHC) were used, most of it being distributed by plane.

The amazingly rapid increase in the use of *synthetic* organic insecticides is indicated by these figures: 1940—287,500 pounds; 1942—2,217,000 pounds; 1944—16,205,000 pounds; and 1952—225,000,000 pounds. The increase from 1940 to 1952 was over 781 per cent, or an average increase of more than 66 per cent per year! These totals do not include *natural* organic and inorganic insecticides. The total volume of insecticides used in North America each year is about 300,000,000 pounds!

Figures for the total *area* to which insecticides are applied likewise are staggering. In broad summary, it can be said that insect-control poisons of one sort or another, up to about 60 pounds per acre, are applied annually to land that produces approximately one-half of our food, forage, and fiber, and a small part of our timber. An estimated 80,000,000 acres are annually involved!

Herbicides are newer, as stated. They affect wildlife chiefly by modifying, and sometimes destroying, the habitat. Both herbaceous and woody vegetation are involved, as are grasses and aquatic plants. Herbicides have not yet attained the use, either in volume or area, characteristic of insect-control poisons. Their potential, however, may be as far-reaching: field borders, fencerows, and indeed the fields themselves, are being sprayed with brush- or weed-killers in every state; and thousands of miles of roadsides, and great lengths of railroad- and transmission-line right-of-ways, are similarly treated. See a later statement concerning benefits.

Finally, there are plans for turning parts of the sagebrush plateaus of the West into grassland in the interest of more and better livestock range. This interest was exemplified in the 1956 Annual Meeting of the American Society of Range Management in Denver, when two half-day sessions were devoted to this subject. The first was entitled, "Control of Undesirable Vegetation"; the second was under the heading, "Possibilities and Economics of Improving Range Land Through Management, Improvements, Weed and Brush Control, and Reseeding." Another possible use for herbicides in the West, now in the testing stage, is in the control of pocket gophers on high-country range. The application lies in the killing of weeds, the preferred cover and food source of the pests. The ironical note is that weeds, now considered a major problem on western ranges, apparently gained their present dominance through the over-grazing of intermixed grasses, primarily by livestock! If accompanied by capacity-rated grazing pressure, herbicides may indeed be the expensive cure, or partial cure, to this instance of wide-scale misuse! No one knows what it will do to birds and mammals.

The history of economic and industrial development in America is replete with resource abuse. One needs only to point to the loss of one-fifth of the top soil from cleared lands; polluted waterways in every state; oil slicks along coastlines; the "cut out and get out" lumbering policy; fantastic waste of gas and oil in some drilling and pumping operations. There are scores of lesser examples. Broadly speaking, the use of insecticides to date has been relatively unrestricted, since frequency and volume of application are in almost all cases the prerogative of the operator. To be

sure, dosage and directions for use, as provided by the manufacturers or agricultural bulletins, afford safeguards of very real value, but, properly perhaps, with emphasis on crop protection and economics rather than safety to game and fish. Therefore, only inadequate consideration has been given to wildlife interests, regardless of their economic, recreational, or aesthetic value. Exceptions have been the very valuable work of institutions and government agencies, often under pressure to provide, or approve, *quickly*, the needed poison for insect or pest control.

It will be of interest to note the use, and regulation of use, of herbicides, which obviously appear to be on the threshold of countrywide employment as vegetation controls. With specific or semi-specific preparations for most vegetative types—broad-leaved forbs, woody growths, grasses and sedges, and aquatics; with methods of application ranging from hand to airplane; with costs far lower than control by machine or hand labor; and with results more certain, or even selective, there is little doubt that use, if permitted, will increase in mushrooming proportions. There will certainly be proposals for region-wide programs of vegetation control—as per sagebrush eradication already referred to—in the interest of a particular group or industry. The ultimate loss to birds and other wildlife, in such events, will seemingly be in proportion to the net destruction of habitat. Transition from sagebrush to grazed grassland, as an example, does not promise improvement in the native fauna.

In appraising the relationships of poisons to wildlife, even in over-broad terms, there are a number of things for conservation folk to be thankful for: (1) insecticide loss to birds and other wildlife is due mainly to secondary poisoning, the result of eating poisoned insects and other life. Toxicity of poisoned insects to birds and mammals is generally lower (in some cases, much lower) than is the insecticide to insects. Lethal dosage from this source of ingested food is far less probable than from primary poisoning, such as the spectacular results obtained from strychnine-treated grain in blackbird control.

(2) The most highly toxic, non-antidotal poisons, such as sodium fluoroacetate (1080), are strictly controlled by governmental agencies and are released only under bond or other trust to responsible persons.

(3) There is considerable research into the effects of insecticides, though much less on the effects of herbicides, on wildlife. Most such studies are activated concurrently with, or after, the poisoning operation. California, Alabama, Wyoming, Washington, Connecticut, Ontario, and numerous other states and provinces have conducted, and still are conducting, valuable studies in this field.

(4) Control of vegetation with herbicides, at least under certain conditions, may be beneficial to wildlife, including game birds, according to a recent study in Wisconsin. In this case, the plant successional stage is changed to the advantage of Sharp-tailed Grouse. Any species profiting from the transition of dense woody cover to grass and weeds might be similarly affected. Somewhat similar results have been indicated on sprayed right-of-ways in New England. Minnesota has reported that aerial sprays are an aid to forestry. Fortunately, the interested agencies in this case appear to be making carefully controlled studies before launching a statewide program. They claim that: "Tests have proved conclusively that the herbicides used are not harmful to wildlife and fish." This presumably, is in reference to direct poisoning; there is no statement concerning the effect to wildlife of changes brought about by ". . . plantation release . . ." or ". . . control of fast-growing weeds and the suckers or sprouts of such broadleaf trees as aspen, birch, and oak . . ." This is deer food *par excellence*.

On the other hand, reasons for apprehension on the part of game conservationists

grow out of certain characteristics of some of the poisons used. For example, hydrocarbons such as DDT, Toxaphene, and Dieldrin may be cumulative in their toxic effects. Thus, single exposures may not cause mortality, but repeated applications, in the same year, or in successive years, may attain lethal concentrations in game birds, and presumably in others. If not killed, physical damage to vital organs or processes may result. Wildlife populations may thus be affected by such insecticides in three ways —outright killing, delayed killing, or a decline in the reproductive rate of the population.

A precise evaluation of wildlife losses, direct and indirect, from control poisons is presently impossible, despite the certainty of attrition and the availability of a literature encompassing several thousand titles. The inability of even an informed analyst, to say nothing of this layman writer, to make such an evaluation is due to nothing more than the lack of results from controlled experimentation; for as stated, most wildlife-poison studies have been of an ". . . after the horse is stolen . . ." variety.

This discussion has been generalized purposely in an effort to be fair to both sides—both legitimate in primary objectives—of an intricate and controversial problem. But in a field as vast as that of insecticidal and herbicidal poisons, one as relatively new and unstudied, and one particularly lacking in the results of objective and controlled investigation, no empirical generalization can be made. The reviewer can only conclude: *There is probably no more needed or opportune field for wildlife research.*

As an obvious recommendation, therefore, the writer urges intensified investigational programs on the part of institutions and governmental agencies, and by wildlife agencies, to the end that factual information ample for sound, renewable, natural-resource management is made available. Such knowledge is not now at hand. The need for it will almost certainly become more acute before the conflict of interest inherent between wildlife values and even legitimate plant and animal control is resolved. Other control programs, involving wide-scale use of new, highly toxic, and inadequately tested poisons, may prove tragic indeed, if enacted.—Lee E. Yeager.

LETTER TO THE EDITOR

The review by Irby Davis of Eugene Eisenmann's "The Species of Middle American Birds" (1955. *Wilson Bull.*, 67:317–318) demands answering comment for a number of reasons. It would be unfortunate if this extremely valuable book did not reach the readership it deserves merely because it does not agree with the personal views of the reviewer in one minor aspect, that of vernacular names.

Indeed, the overwhelming concern in this review is this matter of the selection of common names, and the very first sentence reads, "The main purpose of this little book is to provide a suggested list of English or common names for the benefit of persons visiting Mexico or any of the Central American countries." May I point out a few errors in this sentence? First, the basic purpose of this book is not to provide a list of common names; its purpose and great value is that it provides, *for the first time, a complete and up-to-date check list of the species of birds recorded in Middle America.* In doing so, Eisenmann has done a great service not only to *visitors* to this region, but to all students of the ornithology of the area. It is a complete species list as correct in its scientific nomenclature as is currently possible (with copious footnotes explaining alternate points of view), with a summary of the range of each species, including many unpublished or previously unorganized data; it includes an excellent regional bibliography. The same first sentence seems to imply that the emphasis is on Mexico, which is not true, nor is the book a handy guide for the

traveller. It is not a guide at all. I find the rest of the review, while perhaps not as misleading as its opening, no less defensible.

For example, the reviewer makes this statement that should not go unchallenged: "It seems that we will never know just what constitutes a species." But among modern ornithologists, the species has a well-defined meaning. What we do not yet have in all cases is the factual knowledge that enables us to determine with finality where to put our species boundaries. The more knowledge we have, the more clear and stable will our species boundaries become. The species concept, however, should not be at issue here, nor should the reviewer question (he calls it futile) the goal of a single appropriate name for each species. The A.O.U. Check-list Committee has been striving towards this goal for species north of the Mexican border. Should another principle be applied south of it?

Perhaps the most surprising statement in the review is that "Species are lumped or split so frequently by taxonomists that the amateur field student should not be expected to change his common name for a bird, which he has long known, just because there has been a new technical grouping suggested, and his bird has now perhaps been made a race of some South American species that he has never heard of before." The inferences here are that taxonomists switch birds back and forth like an aimless, endless game of volleyball, that there is no progress towards the ultimate truth in taxonomy, and finally that there is something about the home grounds of the reviewer that makes a race found in Mexico more important in a pan-American species than races found elsewhere.

It may be, as the critic asserts, that some field students want separate names for every subspecies they think they can distinguish in the field. But the purported identification of subspecies is now deplored by all the experts, and there will be no subspecific vernaculars in the forthcoming A.O.U. Check-list. The book in question, furthermore, is a *species* list, and nothing more, although in itself it represents thousands of hours of scholarly work. A demand for names for all the thousands of subspecies seems contradictory from a critic who has just complained about the instability of the (far more stable) *species*. If subspecific vernaculars are ever wanted, Eisenmann has prepared the ground with truly pan-American specific names, which can be converted, with a single modifier, into subspecific names that indicate true relationships, a benefit heretofore generally lacking.

The bulk of the review in question dwells on Eisenmann's *choice* of vernaculars. The review gives the unwarranted impression that the names selected would be strange to current workers in Mexican ornithology. In fact, the names are those found in Blake's well-known "Birds of Mexico" (1953), the only manual and guide in its field, and a work to which every serious student must constantly refer. These names were also adopted in Paynter's "Ornithogeography of the Yucatan Peninsula" (1955), and agree with about 90 per cent of those in Edwards' "Finding Birds in Mexico." Most of the Mexican bird names had previously been used in Sutton's "Mexican Birds" (1951), and were largely drawn from the earlier monographs of Ridgway and Hellmayr. But Mexico was not the only country included in this list, and in choosing the most appropriate name for polytypic species ranging through several thousand miles, access to broad collections is required (which Eisenmann had and the reviewer did not have) and the occasional discarding of a name "long known" in Mexico may have been the only sensible solution.

The field of vernaculars is apparently charged with emotion. I will not comment at length on the reviewer's vague disparagement of the choices, beyond saying that the names particularly mentioned as unwarranted novelties introduced by Eisenmann were

oddly enough not novelties at all. "Slaty-breasted Tinamou" dates back to Sutton's book and was adopted in the subsequent Mexican works mentioned. The same applies to "Spot-breasted Woodcreeper." The use of "Woodcreeper" as the general name for the Dendrocolaptidae goes back at least to 1929, when Frank M. Chapman adopted it in his well-known book "My Tropical Air Castle." This usage has been followed in the Mexican works mentioned and in many other papers on neotropical birds. The name "Woodhewer" translates the technical designation, but creates a misleading impression of destructiveness, while "Woodcreeper" well suggests the behavior and appearance of these birds.

The reviewer is obviously a traditionalist who would hew to the older names, and prefers perfunctory translations of the technical names, no matter how erroneous, misleading, or inappropriate. This attitude is inconsistent with his complaint that technical names show little stability. It is the belief of this writer, on the other hand, that, if anything, Eisenmann was over-cautious on the side of traditionalism. Surely, where Middle American common names are concerned, nothing is "long known." The great days of ornithology in this region lie ahead; for every student of today or reference of the past, surely a thousand will yet come. If changes are needed, better now than later. Eisenmann's list supplies a basis for pan-American uniformity of usage, a great step forward. It probably will never satisfy everyone in every detail, but it is a major contribution, and surely even its severest critic will find constant use for it, for years to come.—Robert S. Arbib, Jr.

A notice concerning decisions on the names for certain birds recently adopted by the International Commission on Zoological Nomenclature has been provided by the Secretary to the Commission, Francis Hemming.

NOTICE is given that the International Commission on Zoological Nomenclature has recently taken a series of important decisions on the names for certain birds regarding which applications to the Commission were published in October 1952 in Part 1/3 of volume 9 of the *Bulletin of Zoological Nomenclature*. Among the decisions so taken the following are of interest to American ornithologists:

(1) suppression of the generic name *Colymbus* Linnaeus, 1758, and acceptance of the generic name *Gavia* Forster, 1788, for the divers (loons) and of *Podiceps* Latham, 1787, for the grebes (*Opinion* 401);

(4) suppression for nomenclatorial purposes of the names by Linnaeus published in 1776 in the "Catalogue of Birds, Beasts, . . . in Edwards' Natural History" (*Opinion* 412);

(5) validation of the name *Columba migratoria* Linnaeus, 1766, for the Passenger Pigeon (*Direction* 18);

(6) validation of the generic names *Bubo* Dumeril, 1806, *Coturnix* Bonnaterre, 1790, *Egretta* Forster, 1817, and *Oriolus* Linnaeus, 1766, by the suppression of older homonyms (*Direction* 21);

(7) acceptance of *Gallinago* Brisson, 1760, and rejection of *Capella* Frenzel, 1801, as the generic name for the Snipe (*Direction* 39).

The foregoing *Opinions* and *Directions* are now in the press and will be published at an early date. All inquiries should be addressed to the Publications Officer, International Trust for Zoological Nomenclature (address: 41 Queen's Gate, London, S.W. 7, England).

In this third supplementary list of the books in the Library are all new titles received since the appearance of List B-2 in December, 1954. Members who would like reprints of Complete List 2 and its supplements may write to the Wilson Ornithological Society Library, Museum of Zoology, Ann Arbor, Michigan.

The Library this year has grown most gratifyingly, especially in its holdings of the major modern reference works—Ridgway and Friedmann; Cory and Hellmayr; Peters; Mackworth-Praed and Grant; Bannerman.

Names of donors to the Library are published in each issue of the *Bulletin*. Members living as far away as Sigfrid Durango (Sweden) and F. Haverschmidt (Surinam) have sent contributions. The exceptional generosity to the Library shown by H. Lewis Batts, Jr., and Karl W. Haller deserves the Members' special gratitude.

The Library Book Fund for purchase of new ornithological works has been nearly expended. Even small donations to this fund result in major improvements to the Library.

BOOKS: List B-3

Books added to the Wilson Ornithological Society Library since publication of List B-2 (*Wilson Bulletin*, 66, No. 4, December 1954:275–276; for Complete List 2, see *Wilson Bulletin*, 64, No. 3, September 1952:176–185).

Audubon, John J. (biog. of). Herrick, Francis H., Audubon the Naturalist. (2 vols.) 1917.

Bailey, Florence M., Handbook of Birds of the Western United States. (rev. ed.) 1927.

Bailey, Wallace, Birds in Massachusetts: When and Where to Find Them. 1955.

Bannerman, D. A., The Birds of the British Isles. (4 vols.) 1953–1955.

Beebe, [C.] William, The Bird: Its Form and Function. 1906.

Bermuda Book Stores, Birds of the Bermudas. Undated.

Buller, Walter L., Manual of the Birds of New Zealand. 1882.

Carr, W. H., Desert Parade. 1947.

Chamberlain, Frank W., Atlas of Avian Anatomy: Osteology, Arthrology, Myology. 1943 [1944].

Chapman, F. M., Handbook of Birds of Eastern North America. (2nd rev. ed.) 1932.

Cory, Charles B., C. E. Hellmayr, and B. Conover, Catalogue of Birds of the Americas. 1918–1949.

Coues, Elliott, Field Ornithology. 1874.

Dalrymple, B. W., Doves and Dove Shooting. 1949.

Dewar, Douglas, Himalayan and Kashmiri Birds. 1923.

Dharmakumarsinhji, R. S., Birds of Saurashtra, India. [1955].

Dobzhansky, Th., Genetics and the Origin of Species. (2nd rev. ed.) 1941.

Edwards, E. P., Finding Birds in Mexico. 1955.

Fehringer, Otto, Die Singvögel Mitteleuropas. [1922?].
Fisher, James, A History of Birds. 1954.
Fisher, James, Bird Recognition. (vol. 3) 1955.
Friedmann, Herbert, The Honey-guides. 1955.
Géroudet, Paul, La Vie des Oiseaux. (5 vols.) 1946–1954.
Gould, John (ed. Eva Mannering), Mr. Gould's Tropical Birds. [24 plates, with Gould's descriptive text] 1955.
Greene, W. T., Parrots in captivity. (3 vols.) 1883–1887.
Grinnell, J., and Margaret W. Wythe, Directory to the Bird-life of the San Francisco Bay Region. 1927.
Griscom, Ludlow, and Dorothy E. Snyder, The Birds of Massachusetts. 1955.
Hausman, L. A., Beginner's Guide to Attracting Birds. 1951.
Haverschmidt, F., List of the Birds of Surinam. 1955.
Hellmayr, C. E., *See* Cory *et al.*
Hendy, E. W., More About Birds. 1950.
Jaques, H. E., How to Know the Land Birds. 1947.
Lowe, Frank A., The Heron. 1954.
Lynes, H., Review of the Genus Cisticola. (including plates) 1930.
McGregor, Richard C., Index to the Genera of Birds. 1920.
Mackworth-Praed, C. W., and C. H. B. Grant, Birds of Eastern and North Eastern Africa. 1955.
Mannering, Eva (ed.), *See* Gould, John.
Matthews, G. V. T., Bird Navigation. 1955.
Mayr, Ernst, and E. T. Gilliard, Birds of Central New Guinea. 1954.
Mayr, Ernst, and E. Schüz (eds.). Ornithologie als biologische Wissenschaft. (Stresemann Festschrift). 1949.
Peters, James L., Birds of the World. (7 vols.) 1931–1951.
Peterson, Roger T., Wildlife in Color. 1951.
Pettingill, O. S., Jr., A Laboratory and Field Manual of Ornithology. (3rd ed.) 1956.
Ridgway, R., The Birds of North and Middle America. 1901–1919.
Ritter, W. E., The California Woodpecker and I. 1938.
Saunders, A. A., The Lives of Wild Birds. 1954.
Savory, Theodore H., Latin and Greek for Biologists. 1946.
Sibley, Charles G., A Synopsis of the Birds of the World. 1955.
Smith, Stuart, and Eric Hosking, Birds Fighting. 1955.
Sprunt, Alexander, Jr., Florida Bird Life. 1954.
Stokes, A. W., Population Studies of the Ring-necked Pheasants on Pelee Island, Ontario. 1954.
Storer, John H., The Web of Life. 1954.
Street, Phillips B., Birds of the Pocono Mountains, Pennsylvania. 1955.
Sutton, George M., Birds in the Wilderness. 1936.
Takatsukasa, N., Japanese Birds. 1941.
Tillisch, C. J., Falkejagten og dens Historie. 1949.
Wallace, George J., An Introduction to Ornithology. 1955.
Wetmore, Alexander, The Migrations of Birds. 1930.
Webb, Cecil S., The Odyssey of an Animal Collector. 1954.
White, T. H., The Goshawk. 1951.

ORNITHOLOGICAL LITERATURE

RECENT STUDIES IN AVIAN BIOLOGY. Edited by Albert Wolfson. University of Illinois Press, Urbana, 1955: 7 × 10¼ in., ix–479 pp. $7.50.

Under the inspiration and guidance of Dr. Albert Wolfson, former chairman of the Committee on Research, the American Ornithologists' Union has issued a book summarizing recent researches in many phases of ornithology. Begun in 1948, manuscripts were accepted from 13 different authors in as many different fields from January, 1952, until April, 1955. Coverage of literature is principally for the period from about 1933, the date of the last summary of researches prepared by the A. O. U. (Fifty Years' Progress of American Ornithology 1883–1933), to about 1952. All articles are comprehensive treatments and contain extensive bibliographies, even though they vary in length from 13 to 71 pages.

Of interest is the shift in emphasis in modern ornithological research since 1933. Eight of the twelve major subjects discussed in the earlier summary—those dealing with territorialism, economics, museum collections and exhibits, photography and art, conservation and education—receive only incidental mention in this one. Perhaps some measure of the increased volume of research that is now appearing is indicated by the present summary for less than twenty years including two and two-thirds times as many words as the summary published in 1933 for the preceding fifty years.

The topics are arranged in a logical sequence and in spite of the large group of collaborators there is considerable uniformity in the organization of the various articles and in matters of style. Proof-reading and editing have been critical, and mechanical errors of a typographical or grammatical nature are practically absent. The compendium could well serve as a textbook for advanced classes.

Alden H. Miller starts the discussion with a definition of the biologic concept of the species and points out how the change from the old strictly morphological concept has stimulated the identifying of isolating mechanisms, the recognition of different degrees to which populations have attained species ranking, and an understanding of the mechanics of speciation. Defects in the use of birds in such studies are the difficulties inherent in obtaining large-scale breeding experiments, lack of large masses of specimens for study compared, for instance, with those available to the ichthyologist or entomologist, deterioration of plumage pigments in stored specimens, inadequate use of statistics, and over-enthusiasm in naming subspecies. Remedies are suggested.

Herbert Friedmann lists modern tendencies in taxonomic practice for uniting and reducing the number of families recognized, for monographic revisions of various groups, and for analysis and interpretation of genera and species from the phylogenetical and geo-historical approaches. Various systems of classification are compared and evaluated.

Alexander Wetmore reveals several points of special interest in paleontology: the uncertainty whether *Ichthyornis* ever possessed teeth, the view that penguins are the most specialized of living birds, the evolution of the ratites from flying ancestors, a cursorial vulture with only weak powers of flight, and a condor with a wing spread of 16 to 17 feet.

Harvey I. Fisher stresses the importance of internal anatomy for defining major taxonomic categories and laments on the lack of such necessary anatomical studies in the present century. He points out, however, the gradual development of the new field of "functional anatomy," wherein comparative studies of structures are emphasized along with detailed correlations of structure with function and environment. The literature of the last quarter century is reviewed on weights, the respiratory system, produc-

tion of sound, comparative anatomy in relation to taxonomy, embryology of wild species, histology of the nervous system, mechanics of flight, and various other adaptive mechanisms.

John T. Emlen surveys bird behavior all the way from the elementary and obvious to the complex and involved, using as his basis the functions of the various behavior patterns. Our present knowledge of neural mechanisms is reviewed. In analyzing the nature and origin of behavior patterns he makes due acknowledgment of the modern ethological concepts developed by Lorenz, Tinbergen, and Thorpe, as well as the criticisms and different interpretations of Schnierla, Lehrman, and others.

In the treatment of bird navigation, Donald R. Griffin adequately disposes of the Coriolis Force, terrestrial magnetism, and infra-red vision in favor of ordinary vision. Three types of homing behavior in unfamiliar territory are described: I, a regular pattern of exploration until familiar landmarks are located; II, take-off and flight in the same direction to which the birds had previously been conditioned; and III, choosing of the correct direction homeward regardless of previous conditioning. Orientation from the sun is probably important with pattern II, while in pattern III, the most baffling of all, the sun may possibly be used both to tell direction and latitude. It is conjectured that the pecten in the eye may play some part in celestial navigation.

Donald S. Farner is primarily concerned with proximate factors for the annual stimulus of migration. Hypotheses in which the gonads, thyroids, and anterior pituitary assume major roles are found wanting. Lengthening photoperiods in the spring stimulate the anterior pituitary, thereby activating the gonads, and along with rising temperatures produce a favorable energy balance. Whether this excess of productive energy is used for molting, immediate initiation of nesting, or deposited as fat preparatory for migration may be under endocrine control of the anterior pituitary. There is strong indication, but not certainty, that nightly unrest of caged birds is a reliable index of the migratory state. Before migration actually occurs, the additional stimulus of critical changes in environmental factors appears to be required.

George H. Lowery, Jr., and Robert J. Newman, describe the accumulating evidence that in nocturnal migration small birds are distributed through the sky with remarkable uniformity. Topographical features are followed only when they offer "leading lines" which the birds are reluctant to cross. The migration peak on any day generally comes during the hour before midnight. It appears that further development of this important field will depend on harmonizing the often contradictory information obtained by telescope counting of bird silhouettes passing across the face of the moon and "chip counting" of birds migrating at lower elevations.

David E. Davis compiles information on the breeding biology of miscellaneous species and emphasizes the need for adequate statistical analysis of data collected.

L. V. Domm cites evidence that embryonic sex differentiation is directly determined by the relative intensity of androgenic and estrogenic hormone secretion and that the intensity of secretion of these hormones is normally controlled by the hereditary genes.

In the longest article in the book, Joseph J. Hickey gives a comprehensive survey of population problems in gallinaceous birds. This includes techniques for measuring population size and analysis of nesting successes, sex and age ratios, cycles, and regulatory factors. Seventy to eighty per cent of the females raise at least one young during any year. Mortality of the young averages 20 to 50 per cent in the first two months and in adults is higher in bob-white (77–84% per year) than in any other species. Sex ratios tend to be balanced during the first autumn after hatching but in monogamous species become skewed towards the male by the second autumn. Annual

fluctuations involve increases with reproduction of less than 100 per cent and decreases with mortality of 50 per cent. North American grouse typically exhibit a 3.5 year cycle north of 55° latitude, but the 9.5 year cycle between 40° and 50° latitudes is less certain and may be due to random action of several environmental factors. California quail can stand only a 25 per cent hunting kill, but bob-white can take a kill of 40 to 55 per cent.

In a second article, Farner discusses problems involved in formulating life-tables. He emphasizes the importance of banding immature birds in order to accumulate a much larger mass of longevity and mortality data on birds of known age. Such data, as far as known, are summarized for a large number of species.

The final paper by Carlton M. Herman is a comprehensive review of the important diseases of wild birds. These diseases are produced by a variety of factors: ecto- and endo-parasites, bacteria and fungi, viruses, and nutritional inadequacies.

Criticisms of this book are difficult to find. The delay of three years or longer in the publication of some of the articles is regrettable. Some of the summaries are more complete and detailed than others, but on the whole, they attain a high standard of excellency. We find no mention in the Index of such important fields as ecology, genetics, social hierarchy, or song—fields in which there have been many recent advances. It is scarcely conceivable, however, that any serious bird student can afford not to have this book continually at hand and to have a thorough familiarity with its contents. Every young ornithologist should make this one of his first purchases.—S. Charles Kendeigh.

The Myology of the Whooping Crane, *Grus americana*. By Harvey I. Fisher and Donald C. Goodman. Illinois Biological Monographs (vol. 24, no. 2), Univ. Illinois Press, Urbana, December 30, 1955: $6^{11}/_{16} \times 10$ in., viii + 127 pp., 40 figs. $3.50 cloth, $2.50 paper.

Doctors Fisher and Goodman have performed a great service to ornithology by writing this monograph, not only because they present data on the myology and neurology of a rare species, but also because they describe the entire muscular system. No longer need the student refer to the inaccurate work of Shufeldt. Nearly all students of avian myology have been misled, at one time or another, by accepting at face value certain statements made by Shufeldt in his "Myology of the Raven" (1890). Hudson and Lanzillotti (1955. *Amer. Midl. Nat.*, 53:2) politely referred to this problem when they stated that Shufeldt's "description of the flexor digitorum sublimus makes it quite apparent that he did not find any such muscle."

Fisher and Goodman give the known history of the three specimens on which their report is based. They present detailed descriptions of the musculature of the following regions: skull and jaws; tongue; orbit and ear; wing; tail; leg; body wall; vertebral column. Synonymy of muscles is given except in the discussions of the myology of the tail and the pectoral and pelvic appendages, for which the synonymy was given earlier by Fisher (1946. *Amer. Midl. Nat.*, 35:tables 19, 23, and 42).

The authors state (p. 39): "Montagna (1945) [*Jour. Morph.*, 76:87–113] demonstrated that the digits of the avian hand are numbers II, III, and IV rather than I, II, and III as in most current literature. Thus is settled, at least to our satisfaction, the hundred-year-old controversy." They have proposed, after consultation with other anatomists, new names for certain muscles inserting on those digits; they list the old names and the new names on page 39.

"The Myology of the Whooping Crane" now becomes the standard reference for the

complete myology of a species. Most myological studies, for several important reasons, deal with the pectoral and pelvic appendages. Consequently, I feel that it is important to point out certain probable omissions and misconceptions of muscle complexes in this otherwise excellent monograph.

Fisher and Goodman do not mention M. expansor secundariorum, a muscle widely used in taxonomic diagnoses. Beddard (1898. "Structure and Classification of Birds," p. 366) states that this muscle is present in the Gruidae and I found it in *Grus canadensis tabida*. It surely is present in *G. americana*. A small muscle closely associated with M. expansor secundariorum is Fürbringer's M. anconaeus coracoideus. This muscle I have described for the Sandhill Crane in two papers now in press; it probably is also present in the Whooping Crane.

M. flexor digitorum sublimus is not mentioned by this name in the paper, but it is described (pp. 65–67) as the "anterior part" of M. flexor carpi ulnaris. The muscle which Fisher and Goodman (p. 52) and Fisher (1946:584) describe as M. proscapulohumeralis is actually the external head of M. subscapularis. The muscle which Fisher (1946:587–588) described as "M. proscapulohumeralis brevis" in the Cathartidae is the proscapulohumeralis (=scapulohumeralis anterior) muscle in that group. Fisher and Goodman (p. 53) also describe a proscapulohumeralis brevis muscle in the Whooping Crane; Fisher informs me (letter dated May 5, 1955) that this muscle was "not found uniformly in the Whooping Cranes." This rudimentary muscle probably represents M. proscapulohumeralis in the cranes.

I believe that it is misleading to refer as these authors do to the *biceps slip* as the belly of M. tensor patagii longus. This is a matter of interpretation, but except when the contrary evidence is overwhelming it is obviously desirable to retain the traditional interpretation of muscles, especially for those which have been used in taxonomic diagnoses.

Fisher and Goodman seem to admit (pp. 89–90) some confusion in the descriptions of their muscles vastus lateralis, vastus medialis, and femoritibialis externus. Fisher (1946:Table 42) stated that his vastus lateralis was the same as the femoritibialis externus of Gadow and of Hudson; his vastus medialis, the same as their femoritibialis medius. Fisher and Goodman (Figs. 29 and 30) illustrate the vastus lateralis (=Gadow's femoritibialis externus) and the vastus medialis (=Gadow's femoritibialis medius) in *G. americana*. The relationships shown in the figures are typical for these muscles. Gadow's M. femoritibialis medius, therefore, is not "apparently lacking" in *G. americana*, as Fisher and Goodman suggest (p. 90). They describe that muscle under their name, M. vastus medialis, on pages 81 and 82.

The muscle which Fisher and Goodman (p. 90 and Fig. 31) describe as M. femoritibialis externus is probably best considered simply a distal head of their vastus lateralis, especially since this would obviate the necessity of lengthening its name to M. femoritibialis externus sensu Fisher nec Gadow. (Fisher did not use the term in his 1946 paper. He illustrated the muscle but did not name it.)

This monograph would be invaluable solely for the 40 excellent illustrations. There are, for example, two figures each of the brachial and sacral plexuses. One of the most significant features of this paper may prove to be the emphasis which is placed on intraspecific anatomical variation. Every taxonomist and anatomist should read and re-read the "Discussion" (pages 119–124) until the implications therein are fully understood. This is, indeed, the type of paper that one wishes one had written. —ANDREW J. BERGER

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Suggestions to Authors

Manuscripts intended for publication in *The Wilson Bulletin* should be neatly typewritten, double-spaced, and on one side only of good quality white paper. Tables should be typed on separate sheets. Before preparing these, carefully consider whether the material is best presented in tabular form. Where the value of quantitative data can be enhanced by use of appropriate statistical methods, these should be used. Follow the A. O. U. Check-List (fourth edition) and supplements thereto insofar as scientific names of United States and Canadian birds are concerned unless a satisfactory explanation is offered for doing otherwise. Use species names (binomials) unless specimens have actually been handled and subspecifically identified. Summaries of major papers should be brief but quotable. Where fewer than five papers are cited, the citations may be included in the text. All citations in "General Notes" should be included in the text. Follow carefully the style used in this issue in listing the literature cited. Photographs for illustrations should be sharp, have good contrast, and be on glossy paper. Submit prints unmounted and attach to each a brief but adequate legend. Do not write heavily on the backs of photographs. Diagrams and line drawings should be in black ink and their lettering large enough to permit reduction. The Illustrations Committee will prepare drawings, following authors' directions, at a charge of $1 an hour, the money to go into the color-plate fund. Authors are requested to return proof promptly. Extensive alterations in copy after the type has been set must be charged to the author.

A Word to Members

The Wilson Bulletin is not as large as we want it to be. It will become larger as funds for publication increase. The Society loses money, and the size of the *Bulletin* is cut down accordingly, each time a member fails to pay dues and is put on the 'suspended list.' Postage is used in notifying the publisher of this suspension. More postage is used in notifying the member and urging him to pay his dues. When he does finally pay he must be reinstated on the mailing list and there is a publisher's charge for this service. The Bulletin will become larger if members will make a point of paying their dues promptly.

Notice of Change of Address

If your address changes, notify the Society immediately. Send your complete new address to the Treasurer, Ralph M. Edeburn, Dept. of Zoology, Marshall College, Huntington 1, West Virginia. He in turn will notify the publisher and editor.

Your 1957 vacation plans should include

THE THIRTY-EIGHTH ANNUAL MEETING

which will convene on the campus of

THE UNIVERSITY OF MINNESOTA, DULUTH BRANCH

DULUTH, MINNESOTA

June 13–16

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Duluth Bird Club

In 1958, the Society visits Oglebay Park, Wheeling,
West Virginia, from April 24–27